AD-A045 708 CONSTRUCTION ENGINEERING RESEARCH LAB (ARMY) CHAMPAI--ETC F/G 13/3
PROCEEDINGS OF THE CIB W-65 SYMPOSIUM ON ORGANIZATION AND MANAG--ETC(U)
MAY 76

UNCLASSIFIED NL

1 OF 2
ADA
045708

(12)

PROCEEDINGS OF THE
CIB W-65 SYMPOSIUM ON
ORGANIZATION AND MANAGEMENT OF CONSTRUCTION

VOLUME II:
OPENING ADDRESSES, RAPPORTEUR REVIEWS, AND DISCOURSES

MAY 19-20, 1976

U.S. NATIONAL ACADEMY OF SCIENCES

WASHINGTON, D.C., U.S.A.

DEPARTMENT OF THE ARMY
CONSTRUCTION ENGINEERING RESEARCH LABORATORY
CHAMPAIGN, ILLINOIS

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* PROCEEDINGS OF THE CIB W-65 SYMPOSIUM ON ORGANIZATION AND MANAGEMENT OF CONSTRUCTION VOLUME II: OPENING ADDRESSES, RAPPORTEUR REVIEWS, AND DISCOURSES		5. TYPE OF REPORT & PERIOD COVERED 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s)		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS CONSTRUCTION ENGINEERING RESEARCH LABORATORY P.O. Box 4005 Champaign, IL 61820		12. REPORT DATE 19-20 May 1976 13. NUMBER OF PAGES 129
14. MONITORING AGENCY NAME & ADDRESS *(if different from Controlling Office)*		15. SECURITY CLASS. *(of this report)* Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT *(of this Report)*

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

Copies are obtainable from National Technical Information Service
Springfield, VA 22151

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

construction
organizational forms
construction management

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This report is the second volume of the proceedings of the Symposium on the Organization and Management of Construction presented by Working Commission W-65 of the International Council for Building held in May 1976. Volume I presented papers submitted to the symposium; this volume presents comments and discussion papers recorded at the symposium. Topics covered include organizational forms for construction, evaluation of organizational forms, and management methods in construction.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

(6)

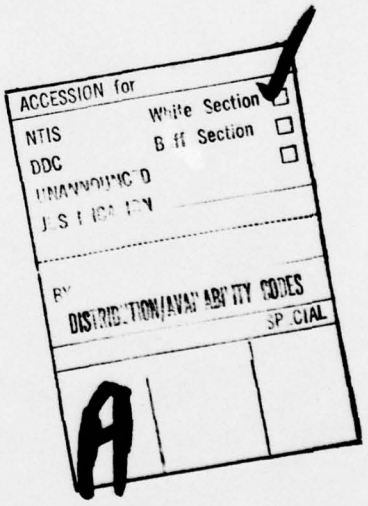
PROCEEDINGS OF THE CIB W-65 SYMPOSIUM ON ORGANIZATION AND MANAGEMENT OF CONSTRUCTION

VOLUME II: OPENING ADDRESSES, RAPPORTEUR REVIEWS, AND DISCOURSES

19-20 May 76
~~May 19-20, 1976~~
U.S. National Academy of Sci...
Washington, D.C.

(11) May 76

(12) 122p.



Department of the Army
CONSTRUCTION ENGINEERING RESEARCH LABORATORY
Champaign, Illinois

405 279

FOREWORD

The Symposium on the Organization and Management of Construction presented by Working Commission W-65 of the International Council for Building was held in May 1976 in Washington, DC. Volume I of the proceedings of the symposium was previously published and can be obtained by requesting Agency Accession Number ADA025317 from the National Technical Information Service, Springfield, VA 22151. The cost for Volume I is approximately $18.75.

During the Symposium, comment was provided by the participants and discussion papers were submitted. This volume of the proceedings, Volume II, presents those comments and discussion papers which were recorded; a malfunction of the recording system precluded presenting the total discussion.

Any comment on the content in the two volumes of these proceedings or on the activities of W-65 can be addressed to either Mr. J. R. Janssens, Secretary General CIB, Postbuss 20704, Weena 704, Rotterdam, Holland, or Dr. L. R. Shaffer, Technical Director, USA Construction Engineering Research Laboratory, P. O. Box 4005, Champaign, IL USA 61820.

L. R. SHAFFER
Coordinator, W-65

TABLE OF CONTENTS

CIB INTERNATIONAL SYMPOSIUM ON

ORGANIZATION AND MANAGEMENT OF CONSTRUCTION

May 19-20, 1976

National Academy of Sciences, Washington, D. C.

PARTICIPANTS

Program Participants

BLESSIS, Dr. George H., Department of Civil Engineering, North Carolina State University, Raleigh, North Carolina 27607, USA

BOYLE, Donald D., AIA-PE, chief, Development Division, Office of Facilities Engineering and Property Management, Department of Health, Education and Welfare, Washington, D.C. 20201, USA

BREYMANN, Bernard H., President, Eco-Terra Corporation, 20 North Wacker Drive, Chicago, Illinois 60606, USA

FOX, Arthur J., Jr., President, American Society of Civil Engineers, 1221 Avenue of the Americas, New York, New York 10020, USA

HILL, Luther, Jr., President, Luther Hill and Associates, P.O. Box 34306, Dallas, Texas 75234, USA

LAW, Alastair G., FRICS, Managing Partner, Sir Robert Matthew, Metcalf & Partners, 1054 31st Street, N.W., Washington, D.C. 20007, USA

PEER, Shlomo, Professor, Head, Construction Management & Economics, Mr. Pollak Building Research Station, Israel Institute of Technology, Technion City, Haifa, ISRAEL

PILCHER, Roy, Professor of Building, Institute of Science and Technology, University of Manchester, Sackville Street, P.O. Box 88, Manchester M60 1QD, England, UNITED KINGDOM

Program Participants

RICHARDS, Major John L., Assistant Professor, Engineering Department, U. S. Military Academy, West Point, New York 10996, USA

SHAFFER, Dr. Louis R., Technical Director, Construction Engineering Research Laboratory, Department of the Army, P.O. Box 4005, Champaign, Illinois 61820, USA

SMOTHERS, Fount T., Head, Department of Architecture, Louisiana State University, Baton Rouge, Louisiana 70803, USA

VANDEN BOSCHE, Richard P., AACE-SAVE-NSPE, 7 Burnbrae Road, Towson, Maryland 21204, USA

CIB INTERNATIONAL SYMPOSIUM ON

ORGANIZATION AND MANAGEMENT OF CONSTRUCTION

Symposium Participants

ADRIAN, Dr. James J., Professor, Bradley University, 5317 N. Woodview Avenue, Peoria, Illinois 61614, USA

ALBRIGHT, Gifford H., Head, Department of Architectural Engineering, 101 Engineering Unit "A," Pennsylvania State University, University Park, Pennsylvania 16802, USA

BAERMAN, Donald, Visiting Lecturer in Architectural Practice, School of Architecture, Yale University, P.O. Box 1605 New Haven, Connecticut 06920, USA

BAGBY, Dr. Gordon, CERL, P.O. Box 4005, Champaign, Illinois 61820, USA

BJORNSSON, Dr. Hans C., Platzer, Bygg AB AND, Institute for Building Economics, Chalmers University of Technology, Fack, S-402 20 Goteborg, SWEDEN

BOLAND, Thomas F., Research Officer Construction Division, National Institute for Physical Planning and Research Construction, St. Martin's House, Waterloo Road, Ballsbridge, Dublin 4, IRELAND

BOYLE, Donald D., Chief, Development Division, Office of Facilities Engineering and Property Management, Department of Health, Education and Welfare, Washington, D.C. 20201, USA

BROWN, Leslie J., Director,General Construction, National Defense Headquarters, BCBN, 101 Colonel By Drive, Ottawa, Ontario KIA OK2, CANADA

BURGER, Amadeus M., Instructor, Georgia Institute of Technology, 545 McAfee Street, Apt. 68, Atlanta, Georgia, USA

CAHILL, William F., 7420 Lakeview Drive, Bethesda, Maryland 20034, USA

CAKIN, Sahap, Research Worker, Department of Architecture and Building Science, University of Strathclyde, 131 Rottenrow, Glasgow, G4 ONG Scotland, UNITED KINGDOM

CAMPBELL, Robert W., McKee Berger Mansueto, Inc., 2 Park Avenue, New York, New York 10016, USA

Symposium Participants

CANDA, Antonio Castrillo, Technical Architect, Ince-Ministerio de la Vivienda, Plaza San Juan de la Cruz, Madrid 3, SPAIN

CHEESMAN, Peter G., Lecturer in Construction Management, Department of Building, Heriot-Watt University, Chambers Street, Edinburgh EH1 1HX, SCOTLAND, UNITED KINGDOM.

CLELAND, Wallace B., AIA, Building Program Coordinator, Office of School Housing, Detroit Public Schools, 5057 Woodward Avenue, Detroit, Michigan 48202, USA

DE ARMAS, Emile, Director, Preliminary Planning Service, Veterans Administration, 810 Vermont Avenue, Washington, D.C. 20420, USA

DENES, Dr. Janos, Deputy Head of Scientific Division, Institute of Building Economy and Organization, Budapest H-1251. Pf. 46, HUNGARY

DIEPEVEEN, Dr. Wilhelm J., General Director, Stichting Bouwresearch, Weena 740, Postbus 20740 Rotterdam, 3004, THE NETHERLANDS

DONAHUE, Paul F., Conti & Donahue, Inc., Representing Associated General Contractors of America, 239 Commercial Street, West Lynn, Massachusetts 01905, USA

DORSEY, Francis J., Director, Engineering and Construction, Beker Industries Corporation, 124 W.Putnam Avenue, Greenwich, Connecticut 06830, USA

DRAKE, Brian E., Chief Surveyor, Department of Health and Social Security, Euston Tower, 286 Euston Road, London NW1 3DN, England, UNITED KINGDOM

ENZMANN, Herbert K., Director, Pioneer Hi-Bred International, Inc., Impact Services Division, 1206 Mulberry Street, Des Moines, Iowa 50308, USA

FENVES, Steven J., Professor, Department of Civil Engineering, Carnegie-Mellon University, Schenley Park, Pittsburgh, Pennsylvania 15215, USA

FREW, Robert S., Associate Professor, School of Architecture, Yale University, New Haven, Connecticut 06520, USA

GRAVES, Hall H., Chairman, Construction Management Program, School of Architecture, Pratt Institute, Brooklyn, New York 11205, USA

Symposium Participants

GROSS, Lester, President, Harbison Development Corporation, P. O. Box 21368, Columbia, South Carolina 29221, USA

HACK, Samuel, Director, Division of Facility and Construction Management, Energy Research and Development Administration, Washington, D.C. 20545, USA

HALPIN, Daniel W., Head, Construction Program, School of Civil Engineering, Georgia Institute of Technology, Atlanta, Georgia 30332, USA

HAMBURGER, Irvin, General Engineer, HQS USAF HQS, Directorate of Engineering and Services-Construction Branch, Bolling Air Force Base, Washington, D.C. 20332, USA

HANDA, V. K., Professor, Department of Civil Engineering, University of Waterloo, Waterloo, Ontario N2L 3G1, CANADA

HOUGUI, Edward S., 12 Hashiv'a Street, Nathanya 42306, ISRAEL

HOUSE, Carl, Director, Economic & Financial Analysis, The Rouse Company, Columbia, Maryland 21044, USA

KIM, Hi Choon, Professor, President, Architectural Institute of Korea, No. 2-7 2-Ka Myung-Dong Chung-Ku, Seoul 100,KOREA

KOUSKOULAS, Vasily, Associate Professor, School of Civil Engineering, Purdue University, West Lafayette, Indiana 47907, USA

KWOK, Chin Fun, Director, Department of Architecture & Engineering, Veterans Administration, 810 Vermont Avenue, Washington, D. C. 20420, USA

LEE, Douglas H., Professor, University of Toronto, 17 Wychwood Park, Toronto, Ontario M6C 2V5, CANADA

LEFTER, James, Director, Civil Engineering Services, Veterans Administration, 810 Vermont Avenue, Washington, D.C. 20420, USA

LEVERETT, James F., U. S. Coast Guard Headquarters, GE CV-3/61, 400 7th Street, S. W., Washington, D.C. 20590, USA

Symposium Participants

LEVITT, Raymond E., Assistant Professor, Department of Civil Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, USA

LIADIS, Steve A., Instructor, Civil Engineering, Carnegie-Mellon University, 1235 Pinewood Drive, Pittsburgh, Pennsylvania 15243, USA

LOGCHER, Robert D., Professor, Department of Civil Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, USA

MARSHALL, Clifton J., Director & University Architect, University of Kentucky, Room 221, Service Building, Lexington, Kentucky 40506, USA

McFARLAND, Russell, Office of Assistant Secretary for Systems Development & Technology, Department of Transportation, 400 7th Street, S. W., Washington, D.C. 20590, USA

MESSINGER, Alexander, Assistant Professor, Graduate School of Fine Arts, Development of Architecture, University of Pennsylvania, Philadelphia, Pennsylvania 19174, USA

MILES, Jerry G., Engineering Manager, American Telephone & Telegraph Company, 295 N. Maple Avenue, Basking Ridge, New Jersey 07920, USA

MILLER, C. Viggo P., Assistant Administrator for Construction Veterans Administration, 810 Vermont Avenue, Washington, D. C. 20420, USA

MITCHELL, George R., Graduate Student, School of Architecture, Yale University, 254 Prospect Street, New Haven, Connecticut 06520, USA

MITCHELL, Rudolf, Foreign Buildings Office, U. S. Department of State, Washington, D. C. 20520, USA

MOAVENZADEH, Fred, Professor, Department of Civil Engineering, Room 1-171, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, USA

MOUTERDE, Philippe, Director, Centre de Liaisons Operationnelles des Chantiers du Batiment, 14 rue de la Gaite, 69006, Lyon, FRANCE

Symposium Participants

MULLER, Frank, Director of Contracts & Technical Director for Construction Management Services, Parson, Brinckerhoff, Quade & Douglas, Inc., 250 W. 34th Street, New York, New York 10001, USA

NAWRATH, Dr. Joachim, Professor, Technische Universitat Munchen, 218 Munchenz Arcisstrasse, GERMANY BRD

NELSON, Richard, Project Manager, Luther Hill & Associates, Inc., P. O. Box 34306, Dallas, Texas 75234, USA

ORR, William R., PE, President, Cost Systems Engineers, Inc., 4907 Ohio Garden Road, Ft. Worth, Texas 76114, USA

ORTEGO, Luis, U. S. Coast Guard Headquarters, GE CV-3/61, 400 7th Street, S. W., Washington, D. C. 20590, USA

PARSSON, Jan, Economic Research Institute, Stockholm School of Economics, Box 6501, S-113 83, Stockholm, SWEDEN

PENZ, Alton J., Professor, Department of Architecture, Carnegie-Mellon University, Box 264, Pittsburgh, Pennyslvania 15213, USA

POPESCU, Calin, Visiting Associate Professor, Department of Civil Engineering, University of Texas, Austin, Texas 78712, USA

PSZENICKI, Dr. Maksymilian, The City University of London, St John Street, London E. C. 1, England, UNITED KINGDOM

RATCLIFFE, Blake J., Director, Research Staff (08H), Veterans Administration, 810 Vermont Avenue, Washington, D. C. 20420, USA

REESE, Edward F., McKee Berger Mansueto, Inc., 2 Park Avenue, New York, New York 10016, USA

ROSSOW, Janet A. K., Graduate Research Assistant, Room 274, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, USA

RUSSELL, Alan D., Assistant Professor, Civil Engineering Department, Consordia University, 1455 de Maisonneuve Boulevard West, Montreal Quebec, CANADA

Symposium Participants

RYAN, Terrance C., Assistant Professor, Department of Engineering, U. S. Military Academy, West Point, New York 10996, USA

SAMI, G., Graduate Student (Landscape Architecture), University of Massachusetts, 416 Prince Street, Amherst, Massachusetts 01002, USA

SCHULTZE, Werner F., Assistant Engineering Manager, American Telephone & Telegraph Company, 295 N.Maple Avenue, Basking Ridge, New Jersey 07920, USA

SILVERMAN, Robert L., President, Sweet Associates, Inc., 228 Maxon Road, Schenectady, New York 12301, USA

SUTTON, Richard, U.S. Coast Guard Headquarters, GE CV-3/61, 400 7th Street, S. W., Washington, D. C. 20590, USA

TAYLOR, Donald C., Managing Director, Construction Industry Research Kellogg Corporation, Suite 400, 5601 S. Broadway, Littleton, Colorado 80121, USA

TAYLOR, Merlin L., Assistant to the President, International Union of Bricklayers and Allied Craftsmen, 815 15th Street, N. W., Washington, D. C. 20005, USA

THOMPSON, Harry E., Chief, Office of Housing and Building Technology, Building 226, Room B-212, National Bureau of Standards, Gaithersburg, Maryland 20234, USA

WAINWRIGHT, Douglas C., Manager, Estimating and Scheduling, Real Estate & Construction Division, IBM, 1000 Westchester Avenue, White Plains, New York 10604, USA

WALLIN, Sten E., Professor, Lund Institute of Technology, Fack 725, S-220 07, Lund 7, SWEDEN

WEESNER, John D., Utility Engineer, Bechtel Associates Professional Corporation, 600 5th Street, N.W., Washington, D. C. 20001, USA

WEISENFIELD, Harvey, Division of Facility & Construction Management, Energy Research & Development Administration, Washington, D. C. 20545, USA

Symposium Participants

WHITE, Joseph C., President, SYNCON Corporation, and Adjunct Professor, School of Architecture and Urban Planning, University of Wisconsin, 1717 S. 12th Street, Milwaukee, Wisconsin 53204, USA

WHITEHEAD, B., Senior Lecturer, Department of Building Engineering, Muspratt Laboratory, University of Liverpool, P. O. Box 147, Liverpool, L69 3BX, England, UNITED KINGDOM

VAN DER WIEL, D., Chairman of the Board, BATAAFSE AANNEMING MIJ, Binckhorstlaan 299, The Hague, NETHERLANDS

WILLERSTROM, Bo., Civilingenjor, Platzer Bygg AB, Fack S-17207 Sundbyberg, SWEDEN

WILLERSTROM, Ingrid, Civilekonom, Mossebergsvagen 17, S-16134 Bromma, SWEDEN

WOODHEAD, Ronald W., Professor, School of Civil Engineering, University of New South Wales, P. O. Box 1, Kensington, NSW 2033, AUSTRALIA

ZINTL, F. Karl, Administrator, Project Control Associates, 224 S. Michigan Avenue, Chicago, Illinois 60604, USA

CIB INTERNATIONAL SYMPOSIUM ON

ORGANIZATION AND MANAGEMENT OF CONSTRUCTION

May 19-20, 1976

National Academy of Sciences, Washington, D. C.

SYMPOSIUM PROGRAM

Wednesday, May 19, 1976

8: a.m. - 9:30 a.m.	Registration (C Street Entrance Lobby) National Academy of Sciences, south side of the 2100 block of C Street, N. W., Washington, D. C. 20418. Registration desk will remain open all day
9:45 a.m. - 11:15 a.m.	Welcoming Remarks - Bernard Breymann, Chairman, USNCCIB
	Introduction to CIB W-65 - Louis R. Shaffer, Coordinator of CIB W-65 and USNCCIB Representative to the CIB
	Introduction of the Keynote Speaker - Louis R. Shaffer, Coordinator of CIB W-65
	Keynote Address - Arthur J. Fox, Jr., President, American Society of Civil Engineers
11:30 a.m.	Lunch (Refectory, National Academy of Science)

1:00 p.m. - 3:30 p.m. Technical Session on Organizational Forms for Construction (National Academy of Sciences Auditorium)

Chairman - Luther Hill (U. S.)
Secretary - John Richards (U. S.)
Rapporteur - Roy Pilcher (U. K.)

This session will be devoted to description of organizational forms utilized in the inception, design, and realization of constructed facilities and the characteristics whereby the form proved to be particularly effective as measured in terms of resources expended to yield the project or the quality of the constructed facility. Emphasis will be on practical examples of research related to the development of methods for decribing forms of human organization in standard terms so that various forms can be compared.

3:30 p.m. - 4:00 p.m. Coffee

4:00 p.m. - 5:45 p.m. Technical Session on Evaluation of Organizational Forms (National Academy of Sciences Auditorium)

Chairman - George Blessis (U. S.)
Secretary - Donald Boyle (U. S.)
Rapporteur - Fount Smothers (U. S.)

This session will be devoted to description of methods and applications related to predicting, measuring, and evaluating the performance of organizational forms; research in synthesizing organizational forms to user client needs; and methods and applications for identifying, prioritizing, and dealing with constraints on assessing client or user needs.

5:45 p.m. - 7:00 p.m. Reception (Great Hall of the Academy)

7:00 p.m. Dinner (Refectory of the Academy)

Thursday, May 20, 1976

9:30 a.m. - 11:45 a.m.	Technical Session on Management Methods in Construction (National Academy of Sciences Auditorium)

Chairman - Alastair Law (U. S.)
Secretary - Richard Vanden Bosche (U. S.)
Rapporteur - S. Peer (Israel)

This session will be devoted to discussion of new management tools or applications of current tools in organizations for the design and production of constructed facilities. Automated and semi-automated systems will be included.

12:00 Noon	Lunch (Refectory of the Academy)
1:00 p.m. - 3:00 p.m.	Summary of Symposium - Louis R. Shaffer, Coordinator of CIB W-65

Adjournment - Bernard Breymann, Chairman, USNCCIB

TECHNICAL SESSION I

OPENING ADDRESS

KEYNOTE ADDRESS

Arthur J. Fox, Jr.
President, American Society of Civil Engineers
Editor, Engineering News-Record
New York, New York

Your purpose, as a building research organization assembled here in Washington for these next two days, is to consider the organizational forms of construction and the way they work, plus some of the management tools available to the industry. As the U. S. National Committee of CIB, it is your purpose to explore and expose the latest results of research into these areas, organization and management.

It is my purpose, as keynote speaker at this conference, to produce for you a picture of the U.S. construction industry, a background against which you must evaluate the significance of the research efforts you will discuss. It is a moving picture that I shall produce, for construction is an industry in a constant state of change. There are clear trends--and some not so clear--that you must consider as you evaluate new ideas in construction organization or management.

Finally, I shall ask of you the real purpose of the research to be explored and whether there might be ingredients beyond organizational forms and scientifically tested management tools in the successful accomplishment of the constructed product.

First, some definitions:

Construction is one of the five basic productive industries by which all things man-made are produced. The five are manufacturing, construction, agriculture, mining, and power generation.

Manufacturing is far and away the largest of the five, but manufacturing divides itself into automobiles and steel and electronics and textiles and so forth--distinct products, using different materials, different technologies, different skills.

If we hold construction together as a single industry, it is the largest single industry, bigger than automobiles and steel put together, bigger than agriculture or mining or electric power.

Construction is home-building, road-building, dam-building, and building-building.

As an industry it has as its basic materials timber, steel, and cement, with other products far too numerous to mention.

Its basic technology is civil engineering, although electrical engineering and mechanical engineering are playing increasingly heavy roles. Architecture and planning also play very significant parts, and dozens of other disciplines get involved these days in the planning, design and execution of construction projects.

The skills used are those of the so-called building and construction trades. The tools used are common to all construction, granting the myriad of special-purpose machines--pavers for road-building, climbing cranes for buildings, etc.

The common denominators of this construction industry are obvious and they are many. Therefore, it is, in fact, a single industry--and in our U. S. economy, the largest.

Please note that in defining construction we are comparing it with the four other productive industries--manufacturing, mining, etc. --and not with such service industries as transportation or communication. It is important that we see construction as a productive industry.

Construction is not a service industry.

It includes many services--professional and otherwise--but the end result is a product, a constructed product. All of the R&D, the planning, the design and the inspection have as their single purpose the production of a product to serve its user's needs, a man-made product delivered with imagination, with integrity, with economy, and with the best possible immediate and lasting effect on the environment into which it is placed.

Further, by way of definition, it may go without saying that construction as the largest single industry--more than 10% of the U. S. economy at about $130 billion annually--is tremendously important to the economy. Anything that can be done to improve the efficiency and the productivity of this big, basic industry is thus worth doing.

Efforts are under way here in the U.S. to pull the fragments of construction together into a single-voice organization that can improve public understanding and recognition of construction as an industry. It is hoped this single-voice organization can articulate

the need for federal policies to bring more stability to this significant sector of the nation's economy. I speak of the National Construction Industry Council (NCIC), which now speaks for 30 national organizations representing the professionals, the managers and the suppliers of construction.

NCIC represents a new recognition here in the U.S. that construction is indeed an industry with a manageable organizational framework, a single language with which it can speak, and a need to communicate its problems, its potentials, its productive genius.

Let us now look at today's organizational forms in construction and talk about the forces for change that assure continuance of the trends we see in the industry today. In this portion of this presentation I shall be quoting in part from chapters in Probing the Future, the April 1974 Centennial Issue of Engineering News-Record, researched and written by the editors of that now 102-year-old construction weekly.

Perhaps the most prominent and the most promising change going on in construction these days is the emphasis on the team approach, the building team concept; this concept stresses the need to aggregate and organize disparate disciplines into a coordinated effort, as well as the need to concentrate responsibility for the constructed product, a demand imposed by the buyer of the product.

The conventional delivery system of the construction product must be replaced. It is ill-equipped to handle projects of growing complex-

ity, size and cost. It is ill-equipped to cope with the proliferation of economic and regulatory constraints imposed in recognition of construction's impact on the natural environment, on the man-made environment and on the social and economic environment.

It is ill-equipped to take full advantage of the growing number of marketplace options in materials, hardware systems and fabrication methods.

Today's more sophisticated owners and buyers of constructed products demand that the formerly fragmented, yet interdependent, responsibilities along the construction continuum be knitted together for efficiency, for assurance of quality, and for economy in products delivered in a timely manner.

Thus it is that we see the continuing trend toward full or fuller capability among design and construction organizations. To some this has meant the merging of architectural and engineering disciplines. To some it has meant diversifying beyond conventional design capabilities into the physical sciences and the soft sciences, into planning, control, and management. To others it has meant offering the design-construct package.

For all, the purpose has been to compete, to survive in a market where the client demands the economies of a more systematic, coordinated approach to construction's delivery system. Each year, as Engineering News-Record surveys the business trends among the ENR

500 design firms and the ENR 400 construction contractors, the trends continue: more design work is done by firms that combine architectural and engineering services; only 54 of last year's 500 performed architectural services only. Much more design is done by design-constructors; the 54 design-constructors saw a 45% increase in their business in 1 year. There can be no doubt that the client today wants a single-source, broad range of professional service capabilities.

Beyond that, the client wants single responsibility for the finished product.

It is for this reason that we are seeing the client--private and public--engaging the construction manager as his agent to coordinate the entire design construct process, and to compress it or telescope its time schedule to reduce costs.

Construction management has been called a concept whose time has come, because of the fragmentation of design and construction functions.

Design remains all-important in construction, says George Heery, Atlanta architect who has pioneered in construction management. "It determines not only the cost but the functional value, the useful life, maintenance cost and almost all of the long-term effects of the building program." Beyond design, however, the design-construct process needs such new--or newly labeled--skills or tools as value engineering, life-cycle costing, computerized scheduling and reporting, and performance specification.

The construction manager can see that all these good things get done--that the planning, architecture and engineering are coordinated with the estimating, scheduling and construction.

There can be no doubt that one way to achieve such project management--the way of the future--is to engage the single organization that can do it all, deliver the project on time and within budget. This single organization may be a single corporate entity or a grouping of separate firms and companies. The important thing is that it must be structured and able to work as a team.

Today's emphasis on economy, efficiency, conservation of resources and protection of environments demands for the future an improved coordination, control, competitiveness--in sum, development--or adaptation from other industries--of a more sophisticated management technique.

In a word, what construction needs is productivity--improved productivity. If this largest single industry could be made just a little more efficient through improvement in design, in construction methods, in labor utilization, and in its use of tools and materials, what a boon to the economy such improved efficiency could be.

For too long in construction, productivity has been considered a labor problem. Improvements in productivity will not come from labor; they will and must come from management or from engineering.

The industry's unionized sector is shackled to its obsolete craft system. The construction trades will remain craft unions, al-

though some flexibility in the craft lines may come about as economic forces simply drive certain products or skills out of the market. For the most part, however, craft line will remain fixed by union industry agreements that delineate the jurisdictions of various craft unions.

One force for change in the productivity of union labor in construction has been the great recent growth of open-shop construction as a formidable competitive force. Work rules are relaxing; restrictive work practices are changing.

For the future, we may look for change brought about by sophisticated owners and buyers of construction. Many today are demanding and getting the flexibility and relative economy of open-shop contracting. In years ahead they may actually specify in their construction contracts the labor relations terms and conditions that they want.

Project agreements are negotiated today among owners, contractors and unions, but the relative strength of the union in those negotiations has institutionalized inefficiencies that proper engineering or good management cannot defend.

It is vital, I believe, that research into construction's organizational forms and management tools not be restricted by the artificial constraints on productivity of today's rules and regulations. Today's delivery system has too much wrong with it for mere tinkering

to make it work better. Construction needs more of the giant-step progress that has come to it with the computer, with project evaluation and review techniques, and with the growth of family-owned companies into top-flight corporations with a management and marketing sophistication unknown in the industry a generation ago.

Research into construction's functions must be unfettered and imaginative, yet it must relate very closely to the real world if its findings are to be appreciated and used.

It has occurred to me in this regard that a great wealth of useful new information might be developed from thorough research into the industry's most extensive private undertaking to date, the ongoing Trans-Alaska Pipeline Project. Might there not be lessons to learn of organizational forms, of their effectiveness, and of the value of management tools used throughout the planning, design and construction of that $7 billion project?

The pipeline has been and continues to be a veritable showcase of what's good and what's bad in construction organization and management. A magnificent delivery system for crude oil is being pushed to completion in 1977, but what about the delivery system that is bringing to completion 800 miles of pipeline unlike any ever built and a billion dollar terminal in one of Alaska's most scenic fjords? What lessons from this huge undertaking might well apply to the management of the smallest projects? What lessons from this

pipeline might the world's construction forces better learn before tackling their next super-project?

We all have been following Alyeska's exciting pipeline project from its start, of course. This year, Engineering News-Record's editors named as Construction's Man of the Year, Alyeska's 41-year-old senior project manager on the pipeline, Frank P. Moolin, Jr. , finding in him a new breed of construction manager.

It is with some observations on Moolin's pipeline management that I shall conclude this effort to provide a background for your conference.

What are the ingredients of success in construction management, beyond the organizational form and textbook management tools?

Early this month I visited the Trans-Alaska Pipeline; I talked to Moolin's men. I listened to bright-eyed 30-year-olds tell me that after that pipeline they could build anything.

Their dream today (as they work their 12-hour days to complete the pipeline) is the next big job, the next big challenge. They want to go wherever in the world Frank Moolin goes--another pipeline, a refinery, whatever.

On a pipeline that has been heavily a civil works, earthmoving project, they have learned management skills they want to apply again and again.

Two things stand out in my mind as a result of my 5 recent days in Alaska:

First, too rarely does a construction job develop the teamwork, the team spirit, one senses from Prudhoe Bay to Valdez. It is one thing to develop organizational forms; it is quite another to have just the right man in every position--a man with just the right age and training and energy and devotion.

Very much earlier in this paper I stressed that construction's organizations must be structured and able to work as a team. Being structured is not enough. Being able to work as a team comes from having worked as a team, from moving up that learning curve by experience in all the interactions that ease communication, establish understanding, and convert ideas easily to actions.

This leads me to a second set of observations, or questions, suggested by the Alaska situation:

How can construction be organized or reorganized so as not to lose the team training, the high level of teamwork and individual skills that are achieved late in the execution of a project? What are the organizational forms best suited to carryover and continuing improvement in the delivery processes of construction? Also, what are the organizational or management forms or techniques that stimulate ideas, imagination, innovation, investigation?

These, then, are some of the questions that I'd hope you might keep in mind as you review research efforts and their results over these two conference days.

I wish you all the best in your deliberations and the results they might produce, and I thank you for this opportunity to speak to you.

TECHNICAL SESSION II

ORGANIZATIONAL FORMS FOR CONSTRUCTION

RAPPORTEUR'S REPORT

Roy Pilcher, Professor of Building
University of Manchester
Institute of Science and Technology
Manchester, England

In this session we are concerned with the description and the means of measuring the effectiveness of different organizational forms which have been, and are being, used in every phase of the process which culminates in the production and use of a constructed facility. Measures of effectiveness may be conceived in terms of the resources expended in the process or by the quality of the finished product. We will also consider the possibility of describing organizational forms in standard terms so that they may be compared. This introductory report is based on the submitted papers and excludes material outside of those papers.

One of the prime difficulties that inevitably occurs is that of defining the words and the terms in use. For example, in the context of our discussions, organizational form is an expression which will necessarily occur very frequently. Sometimes that description conjures up a traditional pictorial family tree, sometimes a matrix showing interrelated activities and jobs, sometimes a series of words, each representing a stage in the design and/or construction process, sometimes a flow diagram representing a management information system, sometimes a contractual arrangement of one sort or another and so on. The evidence for this diversity of definitions is clearly in the papers that have been submitted for this conference.

I thus want to make the point that we all start off at a great disadvantage because we do not necessarily interpret what the next man is saying in terms of our own particular thinking. These pictures that we have are, of course, all relevant and interlinked. They

overlap to the extent that they are often simply different ways of describing the same thing. First, I wish to review some of the different influences on the establishment of a particular organizational form, then, to look at organizational forms in use, and finally to see how the objectives of describing organizational forms and measuring their effectiveness can be achieved.

Before we do that, there is one further introductory comment which I believe to be important and which is necessitated by the subject matter of the papers in general. There is considerable emphasis on the fact that construction projects are growing larger and much more complicated as time goes by. This is, of course, true for some projects but not by any means for all of them. A large proportion of construction activity the world over still consists of small units which are comparatively simple but nevertheless extremely important--particularly at the domestic housing level. The type of builder who executes this form of construction cannot necessarily conceive the organization and the control of his projects in terms of computers, sophisticated management information systems or high level expert staffs with the subsequent expense involved in their employment. It is often more rewarding, however, to carry out research into many of the sophisticated areas that I've mentioned simply because the data that are required are available and organized. We have all experienced the situation where we can go into a large construction company and pick up the data because

they have systems which enable the data to be collected. There is also a reasonable chance of acceptance of the results when the research is completed. The principles of organization are nevertheless just as important to the small firm's organization, as well as to the construction industry if it is to be efficient and play its part in the national economies which we collectively represent. We must be careful in our deliberations not to forget this particular level of activity.

I've made a list of some of the factors which will influence the selection of an organizational form for the creation of a construction facility. These include the nature of the work, the project size, cost and its duration, the availability of resources, both human and material, the quality of resources which are available to carry out the work, the contractual arrangements between the participants, the objectives of the participants involved, whether the owner is a public or private body or corporation, the design of the particular project which is in mind, the risks as seen by the participants in the particular project, whether the work is permanent or temporary, the national economy of the country in which the project is being undertaken and from which the resources will become available, and the availability of control systems. You may want to add to that list in the course of discussion; those are factors that stand out in the papers that have been submitted.

The influence of the factors will vary between projects; not all will apply in every case. When considering organizational

forms in practice, the human element is by far the most dominant and hence by far the most important. Such is the variety of work to be carried out that no one standard organizational form can possibly be adopted for all types of construction projects. Because of the absence of a completely standard building design and the absence of a completely standard form of construction, each project must be different.

As far as the nature of the work is concerned, there appears to be unanimity that construction is different from the well-documented project management of manufacturing entities. Diepeveen (II-36)* draws attention to the fact that the partners in a team which produces a building are required to operate in a project organization even though they do not all belong to the same firm. Their collaboration often ends as the project ends. Often, therefore, continuity of joint experience and cooperation is lost. Richards (II-191) points out that in contrast to most of the manufacturing industries, a buyer is found before production commences rather than after the product is completed.

Project size, cost and duration are obviously important factors in the selection of organizational form. Handa and Ragade (II-110) suggest the limitation which is exerted by project size on the number of different specialist staff members that can be employed in a project organization--as much a reflection of the corporate size of the participants as of the project size. Aird and Handa (II-1) report that

* Numbers in parentheses represent the pages on which the referenced papers begin in Volume I of these proceedings.

pre-knowledge of impending increases in project size was a cause for reorganizing the Ontario Hydro in-house design and construction activities. Both activities were strongly functional and a merger was effected with no fundamental changes being made until deficiencies in the merged organizational structure caused considerable delays in the construction of works. Amongst other factors, Richards (II-191) attributes cost and time overruns to larger scale projects having resulted in changes in government regulations, increasing court litigations, and greater competition by business participants. Burger and Halpin (IV-96) point out that projects are getting larger and more complicated, being characterized by a highly sophisticated interaction between owner, governmental organization, local regulatory agencies, constructor, financer, designer, and subcontractors--resulting in a need for integrated decision-making and parallel scheduling of design and construction activities in order to expedite progress. They estimate that sophisticated project control involving estimating, cost control, materials control and systems administration for a large project may need the involvement of as many as 35-45 personnel. Shaw (II-233) stresses the need for a public authority to exercise strict control on expenditures for large projects. As a result, the assistance of a computer for data processing becomes essential for adequate control.

It is not solely a matter of coincidence that, with the increase in size and complexity of projects, several authors have remarked on the need for a pre-planning group in the organizational form in

order to investigate thoroughly the proposals, design options, budgets and contractual arrangements in order to ensure a viable project and an optimized project content. With larger projects, more data are available for collection. Logcher and Levitt (II-136) believe that the amount of data may well exceed the amount a single project manager can process and use in decision-making. The number and nature of decisions made today are quite different from those which were made by the project manager who was able to direct personally all of these service and operational functions. In larger projects, the project manager's role becomes more diverse. He acts as a problem identifier rather than as a problem solver and thus needs to operate in a broader context than hitherto.

Silverman (II-246) draws attention to the many facets and skills which are required in order to produce a building and which therefore must be incorporated into the organization dealing with such a project. Not least important is the manager of the organization, who must have extraordinary talent and hopefully be skilled in several of the critical disciplines of the project team. Mathur (II-147) comments that in India there is a need for extensive training in construction management in order to provide such leaders. Burger and Halpin (IV-96) in discussing project management and control propose a central group of specialists to coordinate the smaller groups on site.

Contractual arrangements are of considerable concern in the organizational form of the participants in a project. Richards (II-191) cites the contractual arrangements as having the purpose of bringing the product into existence. Difficulties in owner-contractor relationships have led to the development of other forms of contractual arrangements, including turnkey, construction management, design-build and even a single owner-designer-contractor-user in development projects. Popescu (II-174) affirms that state-owned construction firms in Romania retain an owner-designer-contractor relationship with the owner-designer and contractor being involved in the earliest stages of the process.

Handa and Ragade (II-110) suggest that the basic problem of a company is to develop some fundamental concepts and methods of control in order to achieve the company's objective. The failure in the Netherlands to achieve the objective of architecturally acceptable buildings using industrial production methods is reported by Diepeveen (II-36) as having resulted in the use of different methods of organizing the partners in the building project. Richards (II-191) sees the prime goal of participants in the construction process to be business survival--trading off conflicting objectives involving time, cost and quality. Filley* emphasizes the importance of a realistic budget as an objective which needs to be determined early in the project and the necessity of the organization's recognizing this. The role of the cost engineer is therefore important.

* Filley's paper does not appear in Volume I.

The public interest and inquiry into the siting and operation of large plants, as Aird and Handa (II-1) report, complicate the problems of engineering and construction. Silverman (II-246) stresses the role of the owner in the organization and the need to involve him continually in the decision-making process. This may be easier in some forms of ownership than in others. Wearne (II-253) concludes that in some public organizations, a steering committee of top managers is often essential to give backing for a project manager responsible for coordinating people not formally under his executive control.

Design and how it is processed can be fundamental to the organization as a whole. Mathur (II-147) reports that in India the need for large scale housing projects has led to the increasing use of industrialized methods of house construction, thus integrating both design and production. Design is critical in preventing misfits between buildings and their occupants, both in the private and public sectors of the building community. This is the view expressed by Brauer and Preiser (II-15), who note that the approachs to achieving performance quality in facilities differ in the public and private sectors, due primarily to differing organizational forms and procedures. White (II-263) postulates that the use of building systems technology offers great potential for a high degree of managerial control, leading to savings in time and cost.

Risk is another influence on the organizational form to be adopted. Richards (II-191) points out that the buyer who commissions

a construction project has, in a sense, assumed all the risk beforehand, though each organizational form reflects different risk postures for the participants. He concludes that no single organizational form is best for all participants in all situations.

In the less well-developed economies of the world, the problems can be quite different. Often, as Mathur (II-147) reports, the economy dictates new organizational forms for industrial production/construction, research consciousness, innovation, standardization, and prefabrication and systems approach. The introduction of national organizations can help the organized approach and the research consciousness.

The existence of a control system, like that for building systems, can exert a great influence, perhaps too much so, on the organization to be adopted for construction. Once the system is established, whether manual or computerized, and the software is designed and in use, the organization has to conform in order to produce the information as it is required. Logcher and Levitt (II-136) deal with the limitations of the project manager as a funnel through which information must pass for decision-making purposes.

Turning from the influences on the design of organizational forms to the building process, there is little disagreement about the general outline of the process, which consists of planning or programming or both, design, construction, occupation or ownership and evaluation. Descriptions of the process vary only in detail and the

use of different words. This outline is quite independent of the organizational form which will be used to put it into practice. Each of the participants in this process, however many there may be, has its objectives--primarily to survive in business. Additionally, as Richards (II-191) points out, they desire to achieve legal and social survival. The participants are linked together by the existing contractual arrangements. These arrangements are usually selected by the owner, who thereby influences the nature of the participants to be involved. The three basic participants are the owner, the designer and the contractor. The specific form of the contract itself can, of course, vary.

Turning to measures of effectiveness, there is little quantitative information available concerning the advantages of one or other of these organizational forms. There are so many variables, as illustrated by the influences I have already gone through, that the present state of knowledge precludes the pre-determination of the ideal organizational form for the chosen process linked to the contractual relationship to be adopted. In this respect, White (II-263) offers one example in which an integrated set of building subsystems was used in place of conventional construction in a design-lease-contract process, regional shopping center project. The use of the subsystem approach resulted in a reduction of 4.6% in the budget for conventional construction. The final cost to the owner was then 6.8% below the revised budget figure in spite of additional work having been carried out. It would be dangerous to draw a conclusion on the basis of this single item of evidence alone.

There are five commonly accepted types of organizational forms at the project level--individual project, staff project, intermix project, matrix and free-form. Handa and Ragade (II-110) suggest that free-form and matrix are the most adaptable to change, and short term changes of load make them most suitable to construction. They suggest inquiry to determine organizational effectiveness, taking the form of asking specific questions of each organizational form in order to produce a diagnostic report. Such inquiry is standard practice in work study or organization and methods procedures. Aird and Handa (II-1) report on the Ontario Hydro, but no quantitative criteria are given for measuring the success of the changes, though adherence to schedule for projects is now being achieved. It is also concluded that the work program could not have been accomplished with the former organization.

An alternative way of looking at organizational form is put forward by both Frew (II-94) and Mitchell (II-157). Both are concerned with the determination of the appropriate relationships between the various functional activities which are undertaken in building and the way in which a building can be designed or arranged in order to maximize the utility of its organizational form. The methods discussed use a systems approach and apply flow networks and relationship matrices to the optimization process. Clearly such methods will find application in the communication flow in organizational forms, since the analysis

of the internal processes of the organizations necessarily provides the first stage.

Fletcher (II-72) in his paper has proposed a number of ways in which one might deal with these matters. He suggests that the first stage is description of the various activities of the members of an organization. We cannot use job titles alone for this purpose because a member of an organization bearing a particular and apparently specific job title may be engaged upon work which in another organization will be undertaken by an individual bearing another, quite different title. It is the nature of the work itself which is important. He suggests the Construction Industry Thesaurus as a basis for terminology, for the present, with a supplemental glossary provided for those terms not included therein.

Fletcher (II-72) raises the further problem concerning the operations of an organization. Because operations are fluid and change from time to time, he suggests that it may be best to describe the modal condition of the set of parts of the total organization which is devoted to a specific project; this results ultimately in postulating a model project or a most frequently occurring project against which organizational forms can be matched. He goes on to suggest that it is essential that the objective of the initiator of the construction work be identified; the lines of communication must be described as well as the resulting organization, since they may also prove to be of significance. Having established a means of describing organizational

forms, it will then be necessary to move into the area of measuring their relative effectiveness under differing conditions of use so that the decision as to which to use in a given circumstance can be taken with more formal and quantitative guidance.

In summary, I started by referring to the difficulty that arises out of the lack of precise definition and hence understanding of most of the terms used in construction activity. Many of these terms need to be narrowed down in specific areas. One important area is that of the human organization that is used to plan, program, design, construct and evaluate a building project. Unfortunately, all too often the project organization does not have the opportunity of becoming involved in the last phase. The complexity of even defining that organizational form and comparing its effectiveness with others is illustrated by the influences on it which have been considered in the papers submitted for discussion. The lack of quantitative measures for comparing effectiveness is based essentially on the lack of a standard against which such measurement can be made. The development of standards in the one-off project situation is very, very difficult. Even where there is a measure of repetition between construction projects, the structure of the industry with its conservatism and lack of organization, often essentially craft-based, prevents the establishment of a useful standard of effectiveness. The human element is essentially predominant in this work and this in

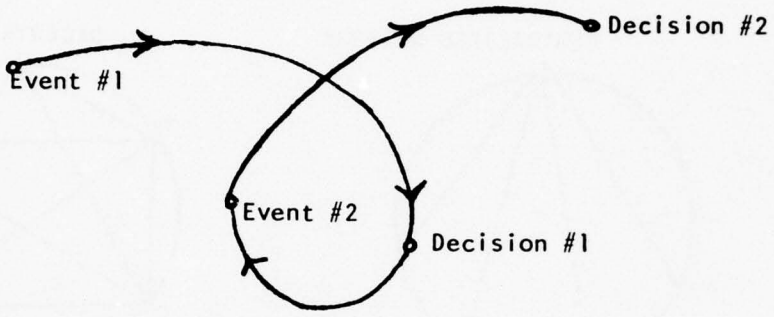
itself often takes the understanding out of an architectural/engineering context into one that is less well understood by those involved. The inference is that such work needs to be undertaken by multi-disciplinary teams, including those skilled in the behavioral and social sciences as well as those having technical construction expertise. The problem is of fundamental and lasting importance and complexity.

LUTHER HILL (Session II Chairman, President, Luther Hill and Associates, Dallas, Texas): Philippe Mouterde, from the Centre de Liaisons Operationnelles des Chantiers in France, has submitted a paper which Professor Pilcher did not have an opportunity to review. Ms. ten Houten will verbally describe that paper, entitled "Communications Networks."

P. MOUTERDE (presented by Liesje ten Houten): Mr. Mouterde is a collaborator in a construction situation in which he serves as a labor negotiator between the architect, the engineer, the construction site developer and his own group of construction workmen (laborers-builders). He has done this as an independent chantier (building site developer) for the past 20 years in a supervisory situation. He represents 40 different groups that collaborate in negotiating building codes relevant to situations and transferring information between groups, and generally participate in the decision-making process of individual construction projects.

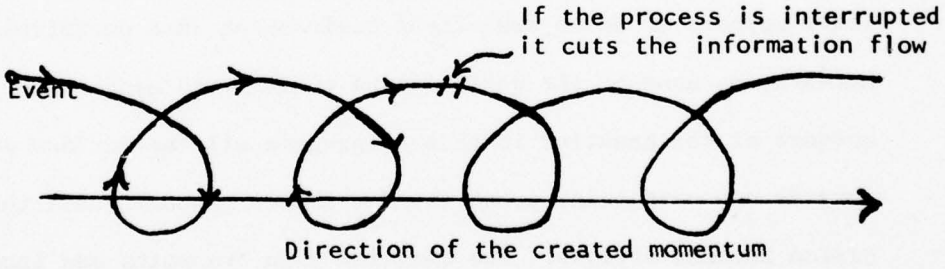
The industrial world which surrounds us has undergone various developmental phases: The Fayol organization; Taylorism; the study of elementary times; the gestation control; the analysis of value. However, in the past 10 years we have seen the development of information and its communication, which are the key roles in management. The decision-making process is a cyclical information-communications process. A decision is made; then, based upon the information fed to that decision, an event is created. This event then sparks another

situation which sets up a search for more information, thus causing another decision to be made--the end result being a cycle of event, information, discussion, decision, order, execution, and the beginning of a new event.



(Figure 1)

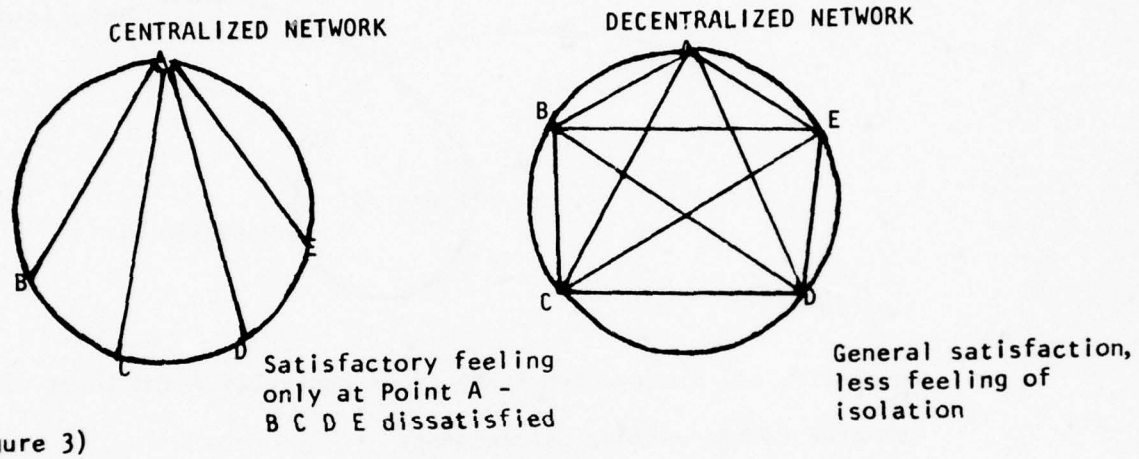
Currently, all information tends to be centralized and later distributed to the various participants



(Figure 2)

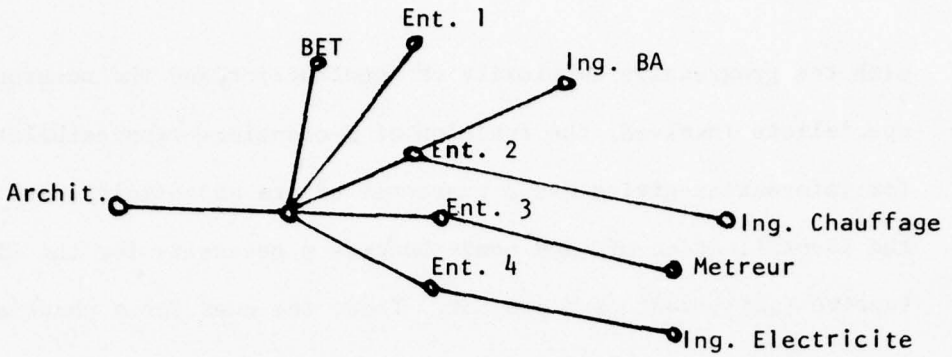
so that they may ingest and interpret it. At this point any error in the information-communications network is not in the actual information gathered, but in the way it has been interpreted vis-a-vis

the situation. Introduction of the word "management" to the communications network implies a need for a notion of a direction. Thus, having a decentralized communications network cuts the error margin.



(Figure 3)

There appears to be an ambivalent environment in a decentralized network, as none of the participants confer with each other. The posture of the chantier is thus to program all the various inputs towards one particular point (find a common ground) until the decision becomes obvious. The chantier then transmits and incorporates all the inputs into a final decision that is agreeable to all and feasible to execute in the particular project being considered.



BILATERAL CONTRACTS WITHIN CONSTRUCTION

(Figure 4)

To complete the organization of the building construction, a continual communications network must be established so that each decision made will be in harmony with the ongoing process. As all participants are bound by bilateral contract, the chantier acts as a central coordinator within the information-communications-giving network. When dealing strictly on the human plane, information given must be consistent and timed within the hierarchical scale and building rhythm. When concerned with the level of technology, information must coincide with the timing, spacing and cost procedures of the actual construction. Finally, concerning the economics of construction, the role of the chantier and the process of information with which he is involved must be cost-effective, or they are not worth the time and effort expended. Thus,

with the progressive complexity of construction and the numerous specialists involved, the function of a chantier--responsibility for information-giving and a guarantee of its objectivity, and the identification of each need--becomes a necessity for the effective fulfillment of a project. Thus, the need for a chantier as a centralized arbiter is great, and his maintenance of a communications network is an absolute necessity.

Questions:

Q. I was wondering about these different people who are involved in the construction plan. Are they subcontractors as we know subcontractors?

A. No, all persons involved in a particular construction detail are contracted on a bilateral basis by the prime negotiator. They all participate together. There are no subcontractors as we know them in France. Perhaps the best way to explain a collaborator is as a coordinating contractor, whose sole business is the management of other contracts.

Q. Would you ask the professor if any of the single entities have any contractual responsibility? What kinds of responsibilities: fiscal, organizational, or what?

A. He does not make the final decision. The most expeditious decision is promoted for all interested parties. All situations are viewed impartially. All bilateral contractors have an

organizational and fiscal responsibility which Mr. Mouterde as chantier coordinates and keeps them informed of.

WILHELM J. DIEPEVEEN (General Director, Stichting Bouwresearch, The Netherlands): You know the real semantic jungle in the construction industry is not the using of different terms, but the failure to define the terms used. However, I wished to comment upon my own paper. Professor Pilcher has said that it might be of value to know how to measure the results of an organizational form. I have described an organizational form, which I call a building team, just as Mr. Silverman has used this term and has used about the same procedure. This team consists of different partners in the building process, including the client and the contractor, who is selected into the team before the tender stage. Use of this procedure for the past 20 years has given me a great deal of savings in total construction projects at the rate of about the difference between the lowest and the highest bidder in any single project. Normally, the difference between the lowest and the highest bidder on a tender in Holland is about 20%. More can be saved in the amount difference between the lowest and highest bidder using a building team. That means that with the use of a building team, the same advantages are obtained as with the strongest competition expected in the normal lump sum bidding process.

JOSEPH C. WHITE (President, SYNCON Corporation, and Adjunct Professor, School of Architecture & Urban Planning, University of Wisconsin): I was very interested in what Mr. Fox had to say this morning about the great needs we have in this industry focusing on productivity, which is one of the biggest problems that we have. As a frustrated industrial engineer and manager who has been involved in the building business for a long time, I was always looking for an opportunity to get at this measurement of productivity and try to define it a little better. My chance came in Toledo, Ohio, where we had an opportunity to work with a developer in trying to put together a regional shopping center. One of the problems that has always occurred in the past whenever we tried to get at some of these issues was the fact that we never had a rational design to begin with. To use a term that seems to be going out of vogue, it appeared to us that maybe building systems and subsystems might still make some sense in this area, so we developed a set of six subsystems which we had preengineered. These subsystems evolved primarily from the California SESD project in the early 60's and are basically designed for school construction. We applied these six subsystems on the regional shopping center job. The new objective from the very beginning was to see if we could get some control over the process and maybe even some control over the labor content. The net result of the project was the proper application of a set of building subsystems in the proper process that could truly save money. Many times in

the past 10 years we have heard talk about building systems possibly saving time, certainly improving quality, but very seldom has it been brought forward that there was a potential for saving dollars, and that is really what the name of the game is supposed to be. On this project the original budget was $5.3 million; the final price was $4.714 million.

If you do have a set of truly integrated subsystems, your design process is much simpler. In this case, we superimposed a set of building subsystems on the traditional design process and immediately became terribly frustrated because we provided the shop drawings in the beginning stages rather than in the final stage, but the architects on the project still insisted on going through the shop drawing process. They took 26 weeks for the working drawings on the job. (It was a 315,000 sq. ft. building.) Our analysis was that if the process had been adapted to make full use of the building subsystems, that time should have been about 13 weeks.

We tried to concentrate on labor productivity. We wanted to set up a construction planning and control system immediately on the job. Since we had a rational design, we thought it was conceivable to ask for daily progress reporting on the project. The general contractor was overwhelmed when this was suggested. He said he had a computer that released manhours and progress on a weekly basis and that ought to be satisfactory. We felt that with the number of men working on the job and the wages that were being paid, checking progress on a daily basis should be feasible.

In industry, progress can be on an hourly basis and sometimes by the minute, so certainly a daily basis was not absurd. Such an accounting would provide some notion of what was happening in order to get at a construction control system of what we did. As a result, the subcontractors who were already involved in the project as consultants were asked to set up a series of meetings to explain the building subsystems and then to go through in some detail exactly the process they were going to be using to install the product. They were then asked to estimate times. A breakdown of the various work activities of the various components was given with an estimate of time. Then the foreman that was going to be involved in the project was asked to develop time estimates. What we were after was some kind of control device.

After time estimates were obtained, they were compiled, and a manual of standard operating procedures for this job was written, with the intent that this particular manual could be used by the owner on his future work. We were now in a position to calculate by trade the percent of effectiveness on a daily basis using the time estimates as a basis for comparison. The number obtained by going through this laborious process of trying to put together a standard operating manual and even a daily labor reporting doesn't itself mean anything unless it has some teeth, so we instituted a system that has been used successfully in industry for a long time. We instituted a daily incentive to the supervisors of the

trades. We gave them a bonus of $15 per day for every day that they met the standard. If they didn't meet the standard, they didn't get the bonus. If they beat the standard and were at 100% effectiveness, for example, they made $22.50. We did this, too, for the general contractor. There were three members of his staff. All were put on a $50.00 per week incentive. These standard numbers, which were only a first crack at control, at least provided some semblance of control. There was no difficulty doing this with labor unions. The whole job was unionized and there were no complaints, even to extending such control to the craftsmen on the project.

In conclusion, I believe that the potential for pre-engineered building subsystems has not been realized, but could be if instituted on more projects with some kind of a control format that would definitely result in improved performances and increased productivity.

MAJOR JOHN L. RICHARDS (Assistant Professor, Engineering Department, U. S. Military Academy): I just wanted to make a few comments very quickly, relevant to Professor Pilcher's summary comment about measuring the effectiveness of organizational forms and the semantics problems encountered. The paper I submitted discussed contractual relationships. The point I was getting at is the risk problem, with a belief that this could be a possible way of getting around the semantics problem and also providing an avenue for

measures of effectiveness in the various organizational forms. I just wanted to take note of this.

WALLACE B. CLELAND (Building Program Coordinator, Office of School Housing, Detroit Public Schools): I noted two or three questions as Professor Pilcher was reporting on the papers, so I will direct my questions directly to him. I would also be glad if the presentors of the papers choose to respond. Professor Pilcher, as you read through the 20 or so papers which you reviewed, were there suggestions from the group as to what sort of industrial organization would provide the standards which you seem to feel are needed? That's my first question. My second question concerns the mention of a need for a pre-planning group in one of the papers. Was the recommendation for a separate group which would have a completely detached objective position separate from the architects, or for construction managers who had been commissioned for the project? Or would this involve those people who were commissioned and who, therefore, might have a possible prejudice or a commitment to see that the project was completed in a certain way? Finally, I would like to know more about the steering committee which would involve the owner, as described in Mr. Silverman's paper. How would it function and what authority would be granted? Would it retain the ultimate authority or is it some how a shared authority?

ROBERT L. SILVERMAN (President, Sweet Associates, Inc., Schenectady, New York): Mr. Cleland has spotted a gap in my paper. It was actually covered in a portion of the paper that I deleted to meet the requirements of length that were imposed upon us. Thus if I may, I will read to you a brief portion of that which was deleted. We are addressing the question of pre-design planning. Mr. Cleland has asked whether I see the pre-design group as being composed of those people who would have a self-interest in seeing that the solution to a specific problem is a building. Those people would be the architects, engineers and construction manager-contractors, etc. I see that there should be a continuing group that is consulting to the owner-client which has no self-interest in seeing the solution to the problem as a building. However, once the solution is determined and that solution is a building, I then see a pre-planning group whose initial function is the development of a management plan.

The delivery of the building product must utilize a systems approach and must employ sophisticated systems technologies to control, to coordinate, and to monitor the process by which the product is delivered in order to maximize the quality and quantity of the building product with a time frame for the delivery that must be achieved. With a functional program in hand, the building team should immediately proceed to develop a management plan. The plan must be sufficiently detailed so as to provide frequent benchmarks. Performance should be evaluated against the plan on a regular basis,

at least once a month. The plan must address the details of the critical general parameters of cost, time, quality of the building, and quantity of the space.

In terms of managing of cost, one must begin with the development of a total project budget. Since the budget will guide decision-making throughout design and construction, it must be carefully prepared. All members of the project team must participate in the preparation of the project budget. Very definitely the owner must play a role. It is essential that all agree that the budget is achievable and that the allocation of dollars is reasonable. The budget for construction should separately address the cost of each subsystem in the building; having 500-1000 separate budgeting components for a project is not unreasonable.

The determination of a budget for a subsystem requires that a level of quality be established for each subsystem. Special consideration for a specific subsystem such as aesthetics for an architectural component should also be separately identified and evaluated. It is important that the designers and construction managers have an incentive to design to budget and that they suffer no penalty for identifying early the dollars in a specific subsystem budget which are excessive and may be allocated to other subsystems. For this reason, pre-agreed lump sum fees for each design firm, consultant and construction manager are preferable to percentage fees. Some members of the team must assume the responsibility for estimating the

cost of each subsystem as the design progresses. By asking the construction manager to guarantee a maximum price, the team is assured of being informed when a subsystem estimate exceeds budget. Many financing agencies have found this to be an effective means of controlling cost. A skillful and experienced estimating capability is essential for the execution of a cost-control system.

Managing time and a management plan must include a schedule for achieving completion of the project. This should be done in pre-design. Because cost is time dependent, budgeting a project requires gross scheduling preceding formulation of the budget.

Considering managing quality, many terms are commonly associated with the management of quality, including life-cycle cost analysis and value engineering. The key to the management of quality, however, is an early statement of desired levels of quality. A financial analyst is needed to assist in the evaluation of operating cost dollars over defined operating cycles against initial investment. Formulation of the management plan should force issues of quality to be confronted early in the project. The plan should also serve as a vehicle for communicating the parameters for decisions regarding quality.

Change is needlessly expensive because it is always considered unforeseen and traumatic to the design construction process. Change must be considered from the initial planning procedure. Areas of particular sensitivity to change should be identified and programmed for flexibility, with the final design and purchase delayed as if

they were tenant work. The cost of change will be minimized when the construction manager buys all possible goods and services directly from the supplier of those goods and services without middlemen and tiers of contractors.

Quantity is often treated as the variable most easily controlled. One of the most significant early inputs from the design team is an estimate of the building quantity in square feet or cubic feet. This estimate must be made by skilled designers with long years of experience in a building type appropriate to the project. Once decided, it must be the designer's responsibility to the project team if the program cannot be accomplished within the estimated square footage. When a cost overrun is anticipated, the project team considers the cutting of square footage. The result of such quantity cuts is a degradation of the program and a loss of carefully considered functional and spatial relationships.

SAMUEL HACK (Director, Division of Facility and Construction Management, Energy Research & Development Administration): We keep talking about productivity in terms of the labor productivity so that we are going towards systems that eliminate labor or where we can be sure of on-site labor at its most productive. In very high technology areas, engineering costs and schedules are very critical elements of the project's success, but I find very little being done by the engineering profession in the area of productivity. Most of us come from an engineering profession and to quote from the cartoon Pogo, "We have met the enemy and they is us." We seem to look at all the

other fields for reasons for the job going badly and not at what we are doing.

At ERDA we are trying as a test case a system taken from the Air Force Systems Command. It will possibly present some problems for us, but so far it has worked right down from structural planning--an engineering effort in very small detail--to budgeting and scheduling and tracking. I just wonder if anyone else has looked into some other solution. The old solution of drawing control in a complex is totally inadequate these days.

LUTHER HILL: Before I ask Professor Pilcher to summarize this session, I would like to make one comment. One of the problems that I think can be addressed very effectively is the appropriate points of trade-off on how you measure things. In particular, when speaking of a construction project, Professor White suggested that we do a daily productivity analysis--that is, finding out how much a particular item is costing in terms of manhours per unit of measure each day. This is a very good idea, but how much does it cost versus how much is gotten out of it? It might be a very appropriate subject for a paper in the future by somebody interested in this particular aspect, because from a very practical side, I know that the contractors who would be doing this type of thing would need to have some guidelines that they could use to determine whether they want to accumulate labor unit costs on a daily basis instead of a weekly basis like most of us do. So, does productivity speed up to become effective through

good value analysis and unit cost analysis? It would be interesting. One more comment about these incentives that Professor White mentioned. Certainly you need to create incentives in the construction process; however, there is an acute danger if you build in incentives in the wrong way. Most of us who have tried the incentive route have come to one form of disaster or other by doing it. Many times, it's because it has been done the wrong way. There might be a good way to do this on a continuing basis. Perhaps this, too, might make a very interesting study. Professor Pilcher will now give a session wrap-up.

ROY PILCHER: I don't really want to put myself in the position of defending the papers that were submitted and have been criticized in some way or other, when these should be defended by the authors and they should be discussed in that way. That is not my task. I summarized the papers and included a number of leading points that were raised. I am rather disappointed that some of the authors sitting here have allowed people to make comments about their papers without responding.

It seems to me that we are definitely quite astray from the point. I stress this question of a quantitative measure of success of an organization. The answer that was given in the papers was to the effect that "Well, if you come out with a cost less than the original budget, it must have been a good organizational form to have used." I cannot accept that. When that happens in a circumstance in

which I'm involved, I go back to the men who produced the original estimate and say you must have made a mistake. That in fact seems to me to be the only conclusion you can draw from that experience, and I cannot accept what Professor White is really saying--that is, that they had a project whose cost came out 4%-6% below budget and therefore the system must have been right. I think this type of situation requires more thought. Budgeting in that way does not really solve the problems that we actually have. In effect, Dr. Diepeveen was saying exactly the same thing. He advocated his method because the organization he used produced buildings that cost less than the estimate. They must have been good, too, since they reduced cost and time. It may be perfectly true--I don't know--but he hasn't convinced me yet.

How we get industry standards was another point that was raised of which I was not aware. You all know as well as I do, at least in the United Kingdom, that market influence upon the lender situation dictates whether you get a wide range of tender prices (between 20-25%) in a range of bidders, or whether you get a narrow one, or whether they are all down the scale or all up the scale. It's that market influence that is terribly important and that defies definition in my view.

The question of a pre-planning group which was also raised did appear in a number of papers. People were finding that it was no longer good enough to accept a client's brief and immediately step

in, design to the client's brief, and start to construct the facility. There seem to be quite a lot of other things to be considered. One of the most important things to be considered in that area is legislation: how it affects design, how it affects the function of the building that we subsequently arrive at, and how it affects the construction process. Many of the authors who raised the question of a pre-planning group took into consideration that this was one of the things to be considered in some depth before embarking upon a design or anything else. It is in that situation that a pre-planning group is introduced. There was also considerable emphasis on the economic appraisal which would be done by the pre-planning groups if they looked into the economic liability of the proposed project.

It would also do to study--and this was mentioned by Worrell (II-276)--the question of bulk ordering. There is the possibility of having some bulk ordering system set up and thereby cutting down many of the overhead costs. This will be a measure of efficiency, if you like, of the particular organizational form. In these days, we are getting more complex structures, with all of the facilities that are involved with such structures, so that's something else that needs to be studied by the pre-planning group.

DR. DIEPEVEEN: I would like to rebut some of Professor Pilcher's comments about the mentioning of measurements. What I said was not to decide to have a building team because it saves you 20%. What I've written in my paper is why you should use the organizational form of

a building team--what advantages there are. However, asked if I could quantify the measurable result, I answered that if you want to know how much you save, my experience indicates that you save approximately the difference between the lowest and the highest bidder. I did not say if you use the organizational form of a building team you get the price of the lowest bidder. I said you have at least the advantage of all the differences between the highest and the lowest bidders, and then you still have all the advantages which come out of a normal tender procedure; that's something different.

TECHNICAL SESSION III

EVALUATION OF ORGANIZATIONAL FORMS

RAPPORTEUR'S REPORT

Fount T. Smothers,
A. I. A.
Head, Department of Architect
Louisiana State University
Baton Rouge, Louisiana

The stated purpose of this session is to provide "descriptions of methods and applications related to predicting, measuring and evaluating the performance of organizational forms; research in synthesizing organizational forms to user-client needs; and methods and applications for identifying, prioritizing, and dealing with constraints on assessing client or user needs." However, the thread of commonality I see running through these papers is far more comprehensive than those terms would imply. I would describe that thread as counter-entropy: a concern for processes of organizing dispersed elements to serve a common purpose.

The most obvious distinction one draws between the papers of the session is between those concerned with the organizational form of the product of construction and those concerned with the organizational form of the process of construction. While those papers oriented toward the organization of the product--Armon (III-1), Frew (III-100) and Lozar (III-135)--did not address themselves directly to the issues around which this session was organized, I think they each offer some very valuable insights, by analogy, into some exciting possibilities for the organization of the process of construction. Of those papers oriented toward the organization of the process of construction, a distinction must be drawn between those which address the issues from the standpoint of the producer/contractor and those which address them from the viewpoint of the owner/client/user. Mr. Pavlidou's paper (II-167) makes this distinction nicely when he says "Most often construction processes are focused

on the needs of the contractor... However, the construction processes should be structurally organized so as to meet both the company's and the client's needs." Mr.Pavlidou then goes on to suggest some very interesting means of, and constraints on, bridging that gap.

Now, the problem that I see as being the substance of this particular session is that upper level owner management, both public and private, who have the responsibility of obtaining facilities to accommodate human activities, are becoming increasingly concerned with the apparent inefficiency and lack of effectiveness which characterize the process of treating the programming, financing, site selection. acquisition, planning, production and operation of constructed facilities as discrete and fragmented functions. In response to those concerns, a variety of innovative organizational process forms, such as construction, management systems, bulk purchase, etc., has emerged in recent years; these forms, in varying degrees, unify the process of providing constructed facilities. The emergence of these alternatives to conventional organizational form presents those upper level management decision-makers with a new problem, that of determining which organizational form is most appropriate to their particular facility procurement problem.

Management decisions between alternative organizational forms for the planning and production of constructed facilities are basically concerned with trade-offs between quality, cost, time and--probably the most important--risk. Typically, an organizational form which offers

an improvement in one of these variables will do so at the expense of one or more of the remaining ones. It seems unlikely that a single organizational form exists which would always be "best" in terms of all aspects of quality, costs, time and risk simultaneously, for all client situations. The relative values, or priorities, attached to various aspects of quality, cost, time and risk will vary between decision-makers and between decision situations as a function of such as things as:

A. The external circumstances (economic, political, etc.) of the decision-makers

B. The context of the proposed facility (potential rewards, available resources, etc.)

C. The degree to which the decision-maker is able to analyze the above factors and is willing and/or able to act on the basis of that analysis (as opposed to acting on unexamined, normative decision rules of "tradition").

The only justifiable reason for the decision-maker to consider alternative organizational forms for the planning and production of constructed facilities is the belief that various forms differ in their inherent effectiveness in responding to decision-makers' demands for the optimization of various aspects of quality, cost, time considerations and risk.

Thus, any systematic or "conscious choice" method for decisions between alternative organizational forms for the planning and production of constructed facilities will require three basic components:

A. Performance Objective Profile, i. e., a process to

1. Articulate the decision-maker's objectives for the organizational form

2. Establish the priorities or relative values attached to those objectives

B. A Performance Evaluation Profile, i. e., a process to predict the inherent capabilities of the alternative forms to successfully respond to each of the decision-maker's objectives

C. Decision, i. e., a process to select the organizational form whose performance evaluations most closely match the decision-maker's performance objectives.

Many of the papers in this section dealt with one or more of these components in very articulate and provocative ways. The French and Haviland paper (III-87), for example, made the point very clearly that "we cannot, and will not, replace natural evolution and crisis-based selections of organizational forms for public construction programs with conscious-choice selection until we establish a comprehensive performance evaluation capability."

The effectiveness of a decision system of the sort outlined above depends heavily on discriminating definitions of the decision-maker's objectives. Clearly, such terms as quality, cost, time and risk are far too ambiguous and open to multiple interpretations to be of very much use beyond providing general categories of objectives for the decision process. One cannot deal articulately with trade-offs between quality and cost until the specific qualities being considered are defined and it is determined whether "cost" is to be defined in terms of initial costs, simple life-cycle cost, or life-cycle cost at some present value discount rate, etc.

One of the factors which tends to complicate the systematic making of articulate and effective trade-off decisions is that we sometimes

have difficulty distinguishing between real objectives and "propaganda." The basic characteristic of propaganda is the use of "glittering generalities" which are not subject to testing or evaluation. Many people tend to express their "desired performances" in terms of such glittering generalities without knowing it. The key to whether a statement of intent is a serious objective or merely propaganda is this: "Will the performance of the system be evaluated in terms of this statement of intent or not?" If the answer to the question is "yes," you probably have an objective. If the answer is "no, it will not be evaluated," you are probably dealing with propaganda.

Ultimately, the discriminations needed to develop articulate decision trade-offs require the specification of the operations by which the performance will be evaluated. For example, the distinction between the objective of minimizing initial cost versus that of minimizing life-cycle costs can only be made clear when one understands the operations by which each is measured and evaluated.

The specification of the following four pieces of information is required to operationally define an objective for trade-off decisions:

A. Goal - The general intent of the desired performance of the organization form

B. Operation - The way the performance will be evaluated or predicted

C. Criteria - The range of evaluation or modeling results which will be acceptable

D. Environment - The context or external conditions under which the performance will be evaluated.

Mr. Cleland's (III-77) paper reinforces the French-Haviland (III-87) paper by contrasting the four diverse efforts to evaluate the performance of alternative organizational forms in the environment of public school buildings. However, Mr. Cleland goes on to suggest three qualities for useful evaluations: unbiased and independent reporting; overall perspective of complex interrelated aspects including social and political issues; and genuine concern for user/client needs. However, Mr. Cleland stops short of making any suggestions as to how these evaluations might be translated into a model by which a decision-maker could generate a predictive evaluation of how alternative organizational forms might be expected to perform in terms of the decision-makers unique performance objective profile and how an innovative organizational form might be generated in direct response to that performance objective's profile.

Two of the papers do in fact deal with this exact problem, but in an entirely different context. The problem is, in essence, one of design. How does one "design" (or select) an organizational form in response to a unique profile of performance objectives. Professor Armon's (III-1) paper deals with exactly that problem in the context of designing or selecting "Optimal Routes in Linear Construction Projects," much in the tradition of Marvin Manheim's Hierarchical Structures. What we need in this session, however, is "An Algorithm for the Determination of Optimal Routes to the Procurement of Constructed Projects."

Professor Frew's (III-100) "House Machine" again deals with the proble of a systematic method of generating an optimal (or "near optimal" for

the purists among us) response to a decision-maker's performance objective profile much in the tradition of Christopher Alexander's Hidex or Professor Murry Maline's work. He states that "the main advantage of the automated method is the ability of the designer to document the client's opinion on the design and to be able to discuss those without the client going around in circles or finding they have run out of time and just have to make a decision." That sounds a lot like Professor Haviland's "crisis basis" for selection of an organizational form. Professor Frew goes on to say that "although this decision has been limited to single houses, there is no reason why this could not be used on housing projects, etc." Is there any reason why a similar "design machine" could not be used to determine the configurations of an organizational form suited to the particular needs of a client?

There is probably no single aspect of the total process of devising, producing, and using constructed facilities which is quite so controversial and so developed as the evaluation of "quality." Yet, there are few aspects of that process which are ultimately quite so critical to the decision trade-offs we are considering here.

Perhaps because of the controversy regarding how "quality" should be evaluated and because of the weakness of our methodologies for such evaluations, there is a tendency to attempt to evade these issues and concern ourselves only with the more manageable problems of minimizing the consumption of resources such as dollars, energy and time. However, that approach is ultimately untenable because the best way to minimize

resource consumption (cost, energy and time) for any project is to not build at all. The only reason to undertake the design and production of a constructed facility is the expectation that the value of the benefits derived from the use of the facility will exceed the value of the resources consumed in its design, production and use.

Mr. Boland's (III-26) and Professor Meyer's (III-155) papers deal directly with systematic methodologies for analyzing decisions related to the selections of organizational forms under the assumption that "the only reason to undertake design and production of a constructed facility is that expectation that the value of the benefits derived from the use of the facility will exceed the value of the resources consumed in its design, production and use."

Mr. Boland (III-26) proposes that a performance based version of Value Analysis/Engineering be applied to the decision analysis. His argument constitutes a very convincing response to Professor Haviland's (III-87) plea for a "comprehensive performance evaluation." But is it really quite that simple? Perhaps it is that simple. Perhaps we are making our own complications. However, in reading Mr. Boland's clear, direct argument, one tends to become concerned lest some very important user needs fail to be identified as "primary objectives" and that the baby may get thrown out with the wash.

Again, I found Professor Meyer's (III-155) treatment of the trade-off between expected benefits and the resources required to obtain them very compelling. There is something almost unarguable about the logic

which says, "the value of a non-cash benefit such as privacy may be defined in terms of dollars by carefully questioning a building owner to determine how much he or she would be willing to pay for an added increment of such a benefit." This paper deals directly and articulately with the idea that value is subjective and often irrational and that the value of a "benefit" can only be measured in terms of what the decision-maker will knowingly sacrifice in order to obtain it. Professor Meyer here offers a clear and sophisticated method of relating the objective and subjective evaluations discussed by Mr. Cleland. Thus, at the highest levels of decision-making the quality of a constructed facility must be evaluated in terms of what that facility is supposed to do.

In general, the provision of constructed facilities is an instrumental means rather than an intrinsic end. The purpose (what it is supposed to do) of a constructed facility is to provide physical, psychosocial and symbolic (or metaphysical) support for some set of human activities. Thus, the "quality" of a facility must be evaluated, finally, in terms of its effectiveness in providing the set of support functions necessary to optimize the set of activities for which the facility is intended. These supports may range from purely utilitarian to purely aesthetic. Mr. Lozar's (III-135) paper deals with aesthetics in terms of the revisions for an office and their effect on the productive capacity of the people who work in the office.

This concept applies to the subsystems and components of a facility

as well as it does to the facility as a whole. The real quality of a heating system (for example) is determined by its effectiveness in doing what it is intended to do, not in how well it is made or what it is made out of. However, there may be an important distinction between the methods appropriate to evaluating the performance qualities of a facility as a whole and those appropriate to the evaluation of subsystem and components, in that the purpose of the facility as a whole is to support a set of human activities. This suggests that the methods and concerns of the behavioral sciences may be more applicable to evaluations of "quality" in a facility as a whole than those of the physical sciences, which may be more appropriate to the evaluation of the subsystem.

Mr. Cakin's (III-59) paper offers a closely reasoned analysis of Danish Industrialized Housing which offers some insight into why we sometimes lose sight of the expectation that "the value of the benefits derived from the use of a facility must exceed that of the resources consumed" on the one hand and of the necessity of providing sufficient incentives on the other. He points out that "manufacturer and contractor sponsored models (or organizational forms) do not seem to meet the needs of the future because of their short-term interests and profit motivation." Elsewhere, he notes that in producer-dominated organizational forms, "some vital decisions concerning the identification of real user needs and the translation of them into an architectural brief remain on the periphery, rather than being the focus . . ."

Cakin goes on to observe that "designer/architect sponsored models (or organizational forms) are not capable of meeting the rapid evolving mass-demands of the building industry because of their small scale and isolated nature." He concludes that "client sponsored models seem likely to be most efficient approach...." Although one may intuitively agree with Mr. Cakin's conclusions, one wishes they were backed up by something more substantial than Mr. Cakin's subjective feelings.

The idea of the dynamic impact of competitive economic impact on the determination of organizational form is very clearly articulated by Mr. Bagby's (III-17) paper, which uses regression analysis to correlate the growth of industrialized building with the ratio of wages of industrial workers to those of conventional construction workers.

The other points that these papers cover are information and predictability. Regardless of what the decision-maker's quality/cost/time performance objectives profile may be, the key to intelligent decision-making is the predictability of the performance of the alternatives open to the decision-maker, and the key to predictability is information.

There is only one way to predict anything and that is to assume that past experiences can be projected into the future in some way. Thus, prediction and therefore intelligent decision-making depend on some form of documentation of historical data. Two papers, those of Mr. Orr (III-182) and Professors Halpin and Woodhead (III-117), deal with information systems designed to document historical data and

filter it for the purpose of prediction and decision-making.

Mr. Orr (III-182), with the "Orr" system, appears to be accomplishing what many of us have wished for some time to accomplish, that is, a comprehensive system which utilizes an additive data bank to predict. Mr. Orr's system is limited to cost and time. While these are extremely important and significant concerns, one wishes to see a parallel system aimed at the prediction of "quality" in performance terms. Again, while cost and time are important, the cheapest and fastest solution to any facility procurement problem is "forget it--don't build." The only reason to undertake a facility procurement project is the assumption that the value of the benefits derived from the use of the facility will exceed the value of the resources expended in its design, production and use. Why don't we have papers on an "Orr System for Performance Through Historical Models," or an "Application of Data Base Methods to Complex Project Performance?" Professors Halpin and Woodhead's paper (III-117) also addressed the problem of information, but again from the standpoint of the producer rather than the owner/client.

The other thing to look at is risk. Professor Moavenzadeh and Ms. Rossow's (III-168) paper on risk analysis is, to my mind, one of the most provocative and interesting papers of the session, because it deals with the idea that predictability itself is one of the strongest determinants in the dynamics of the construction "industry" and one of the strongest determinants in the decision-maker's choice

between organizational forms. However, this paper considers the risk only from the producer's point of view. A parallel analysis of risk from the owner-client's point of view would have been most welcome.

Many (if not all) decisions in the process of planning and producing constructed facilities must be made on the basis of something less than absolute certainty as to the results or outcomes of those decisions. That is, decisions regarding constructed facilities must be made with less than complete information about the future and how future events will affect quality, cost and time. There is a certain degree of risk associated with all decisions related to constructed facilities.

Concern about the risks involved often appears to have an overriding impact on a decision-maker's choice between alternative organizational forms for the planning and production of constructed facilities. This is justified at least to some extent, because any responsible decision-maker will seek to minimize his risk, especially when the "stakes" are high,as they frequently are in the planning and producing of constructed facilities.

For example, assume a local school board has $1,000,000 and has a choice between one way of building the school which is fairly predictable and is probably going to cost in the area of $900,000, and another way which is not certain--it's never been done before, an innovative way--and would probably cost only $800,000 but may cost as much as a million? The choice would probably be the conventional way, because

the risk of exceeding the bond issue and therefore having to go out for another bond election which would probably be defeated is an overriding interest. In other words, concern with not exceeding the bond issue takes precedence over minimizing the cost of construction. We frequently talk about our desire to minimize the cost of construction. I would suggest to you that that is frequently propaganda. What we usually want to do is make certain that the cost of construction does not go over a certain figure that is established by outside concerns. Similar arguments could be advanced with regard to risk and objectives that deal with performance or time.

However, decision-makers frequently appear to react to the recognition of factors of risk and uncertainty in an overly concerned way. That is, decision-makers often appear willing to accept excessively high premiums in cost or sacrifices in performance, quality or time in order to "eliminate" (actually it's only to reduce) risk. Would the decision-makers in the school problem still be justified in accepting the conventional appraisal if the premium was raised to $200,000? $300,000? $500,000? Certainly, at some point the "risk" becomes worth taking.

It is imperative that a systematic method for evaluating alternative organizational forms include a rational method for evaluating factors of rish for the planning and production of constructed facilities.

Obviously, risk is affected by the external circumstances (economic, political, etc.) of the decision-maker as well as by the predictability of alternate possible outcomes. Thus, the subjective "unequal utility of money" has to be considered, which goes back to Professor Meyer's (III-155) paper.

Taken as a whole, there appears to be a certain unity within the diversity of the papers in this session. There are a number of somewhat tentative beginnings, but I sense a current and a direction running throughout most of the papers. There seems to be an implied consensus dealing with the possibility of more effective and systematic methods of evaluating the performance of alternative organizational forms, of making more rational decisions between existing ones and perhaps of generating innovative ones which are more responsive to the needs of both the owner and client community and the producer community.

SAHAP CAKIN (Department of Architecture and Building Science, University of Strathclyde, Glasgow, Scotland): First a few words about the problem of evaluating and assessing processes and then a few comments about Professor Smothers' comments on my paper. I must say that there will never be an absolute, universal criterion for assessing and selecting processes, especially if these processes are about human problems. In our case I think the processes are concerned with organizational forms. But never mind the processes, we have trouble even defining the quality of the product, so rather than comprehensive criteria, we should probably have some partial ones, each depending on the situation and the number of factors. One factor would be whether the project is a new building project or a commercial rehabilitative scheme. Another factor is the type of building--whether it is a housing or a school-education or public building. This too would probably affect the selection of the process or organizational form. Another factor is the economic and political system to which the process is applied. Political factors strongly influence a socialist economy; the situation would be quite different from a democratic one. Another group would be the cultural and social factors. In this way the process selection will probably be affected by the cultural and social characteristics of the community. However, in my paper, what I really would like to propose in the limited context of Denmark is that perhaps some aspects of the performance of a process, of an organizational form, could be measured by the

performance of the constructed facility or the product. I probably agree here with Professor Smothers in his comments that the quality will not be measured by the materials, the performance, the cost or the time but only by the degree that the product will meet the needs of the society, of its users in the long run. If we look around at the many different parts of the world, we see that the cheapest, most quickly designed and constructed facilities are not necessarily the ones with which the users are happiest. For example, in Denmark about 30% of the most efficiently built housing units in the late 60's and 70's are empty; nobody wanted to live in them. Thus, I think quality is much more complex than is currently considered; perhaps in the future the quality will be defined and evaluated more by behavioral, social and psychological work.

Finally, Professor Smothers was correct that in my conclusions the Klein-sponsored models seemed to be better than the others; the reason was the others were deleted due to the space constraints. However, in my original paper, I had included criteria such as inner flexibility of the market risks, innovation of the system, and the user's level of satisfaction, backing these with some empirical data. I would also like to mention that my Scandinavian models conclusion could only be valued for a very specific situation, at a certain time and at a certain place, and for a certain building type. The place was Denmark, the building type was housing in which industrialized production methods have been used and the time was late 60's and early 70's. Probably in a different cultural environment the situation would be completely different.

JOACHIM NAWRATH (Technische Universitat Munchen, Germany BRD): Thank you for giving me the chance to tell you something about the optimal route problem discussed in our paper. The algorithm shown in the paper is called computerized planning of inert construction, that is, roads, canals, pipelines, cables and so on. Computerized planning of construction is not new, of course; you all know about the optimization of earthmoving in road construction. Existing programs and algorithms, however, need a given corridor within which they make the optimal choice. This algorithm finds the optimum route between a given point A and a given point B of particular landscapes. Preparing the input requires two steps. The first is estimation of the basic cost. The basic cost may include construction costs, maintenance costs, and operational costs, including all those costs which will be incurred in bringing one unit from point A to point B. It therefore covers all costs incurred. The basic cost is the minimum cost for a route between the two points, as it is estimated in the best conditions of the survey area. Logically, the best conditions do not normally exist and there are quite a lot of varying conditions: geological conditions, water supply restrictions, etc. The second thing is thus to define all the conditions that will influence the costs and break them down into construction costs, maintenance cost and operational costs.

Of a series of slides which I unfortunately cannot show you, as my slides are too thick for the projector, the first illustrated

the basic estimation of the costs of the construction, maintenance and operation. All these costs depend on the system of transport desired for this kind of structure. Take as an example a pipeline; to be considered in the total survey are the diameter of the tube, the costs for labor, the cost for materials, the costs for energy, and the interest rates. The second step of the investigation is to determine the local influences with which you must contend. You have to define the influences and what is important in your planning. For each condition considered, a map is made. A geological map, for example, would show all the influences: rocks, sand, gravel, swamps, etc. The next map would consider the density of the population. Another map would give the agricultural view of the landscape, i.e., no use, intensive use, etc. All these conditions influence the cost of the pipeline.

When four or five or six maps have been prepared as roughly or as polished as desired, they must be digitized. That means you have to put them into the computer. There are some digitizers on the market right now in the United States. They can read colors from a map and, in about 3 minutes, produce a map of about 2000 units in a table and on a disk, indicating what input is required.

Next you have to evaluate the conditions. One of the most important factors is, of course, the lay of the landscape. The longitudinal and transverse inclines are very difficult to incorporate into our equation. Building a pipeline on a very high slope of say 20, 30, or 50% inclines is much more expensive than placing

it on flat land. This is very important with regard to the operating costs, since being on a slope requires more energy to pump the oil. All such impacts must be evaluated. Different curves can be developed to show the influence of these slopes on the operational (pumping) costs along with the influence of the transversal slope on the construction costs. This creates the input that is necessary for a program run. The output, produced on computer paper, is the given route which is most advantageous given the factors fed into the program, that is, a surface problem solution.

You then enter all the conditions that might be considered with regard to tunneling through a mountain if you have to contend with mountains. It is important to change all the parameters; it takes only a few minutes of computer time to change the costs of tunneling from 50, 100, 200, 400 or 500% of the surface ratios. Any variable within the given base problem can be changed without either reentering all the data each time or changing the basic directive, but each change, each parameter altered will yield a different interpictation and/or solution by the computer. While watching the screen of the computer, you can set your parameters and redesign your routes to give optimum feasibility. In the example of laying pipeline, the computer gave 3-5 different routes, including one tunnel solution, all by changing the cost input. This is an interpretation of the input which means a variation of the input, a variation of the basic cost levels, a variation of the parameters involved and a variation of the sources encountered.

Alternatively, the best points for starting and ending the transportation system can be selected; the computer will then give you a total cost study for every solution studied.

I do not feel that this kind of computer planning diminishes the planner's work because you have to know what conditions are to be covered and how to study the variables and their priorities as you would have to do in a normal planning situation. The one difference between use of a computer to consider the variables and a planner considering the variables is that perhaps the computer is more accurate. We didn't apply a praxis, but we made some models which I unfortunately could not show you. Thank you for your attention.

Questions:

Q. Dr. Nawrath, one point I didn't get was when you spoke of your project costs. You are of course looking at the operating costs, the costs of pumping oil through the line or some similar operating cost, and all other costs. Do you project ahead several years to calculate inflationary growth, maintenance, etc.?

A. Yes, of course to calculate your basic costs you have to think about, for example, 30 million tons per year and a 40 year system lifetime. This you bring into the basic cost equation. A calculation is made assuming 100% growth, with 20% for cost of erecting, 10% for maintenance and about 70% for operations.

THOMAS BOLAND (Research Officer Construction Division, National Institute for Physical Planning and Research Construction, Ireland): The paper that I put forward, "Proposals in the Codes for Evaluating Organizational Forms," is based on the premise that analysts should be capable of conducting the studies to the exclusion of all knowledge of existing organizational forms, except of course in the particular case where an existing organizational form is to be individually analyzed. This approach would eliminate all preconceptions of organizational forms and enable analysts to explain to the fullest the concepts of learning at the command of the various disparate entities operating both within and without the construction industry. In order to treat comprehensively the evaluation of the subject, this paper advocates the adherence to an agreed program. The program advocated is broken down into five phases. Phase I involves an identification and an evaluation of the necessary functions. Phase II involves the determination of the possible alternative ways of having these functions realized. Phase III is subdivided into two phases; phase III-a is a determination of organizational forms performance requirements. It is not sufficient to have the organizational performance requirements unless you also have criteria by means of which you can assess these performance requirements. Phase III-b involves fulfilling that particular requirement, and Phase IV involves selecting the particular alternative to satisfy the necessary functions that would yield the kinds of performance that would be expected of the organizational form. Finally, as researchers,

we must at least put forward a model to enable clients to select the organizational form that would best satisfy their particular functional requirements and their particular performance requirements. In this paper I have given an analogy/comparison of this organizational form using an ordinary column.

Now, I would like to devote some time to suggesting possible future developments of the ideas put forth in the paper. We see the analysis that I envisage, which involves necessary functions and performance requirements. When this has been carried out in an organizational form per se, then I would think the next step is to conduct a similar analysis of individual organizational form components. I refer to these as entities in the paper; by that I mean different professions, i.e., architects, engineers and so forth. When that is completed or maybe at the same time, we should also conduct a similar analysis on individual existing organizational forms, that is, design tender built, packaging, turnkey and others. Equally I would like to see research resources being applied to develop a technique that would allow the variable expressing each performance requirement of a subject to be related to a common unit so as to enable a more objective comparison to be carried out. I referred to this in the paper where I tried to add together stress units, pascals (pounds per square inch in the imperial system) and the length unit, the dollar. They don't add up in terms of a common unit.

In examining table 2 of the paper, we immediately observe that

in evaluating organizational forms per se we are restricted to a consideration of entities whose functions are currently accepted and hallowed by tradition. Once we take the second step advocated in the area of evaluation of the particular entities themselves, we should not expect new entities nor an amalgamation of certain existing entities nor an elimination of certain of our own entities. This last expectation would quite naturally imbue a fear among certain entities that their role as practitioners in the construction industry might be declared redundant. This is very understandable, but the construction industry is changing its traditional character. The entities within the industry are obliged to evolve and become more relevant by redefining their functions and ascertaining the performance expected of them. Those entities that do change will survive to contribute to the industry.

The whole purpose of CIB W-65 is to facilitate technological advancement in this area. I am suggesting that such an advancement cannot be fully achieved without a searching analysis of all the individual entities which in one form or another combine to provide the organizational forms we devise for the industry. An acknowledgement and request for tradition was most certainly a form of thinking, but tradition must not be allowed to frustrate the evolution of new and more effective organizational forms to meet the needs of an industry which each year overthrows accepted but outmoded traditions.

In conclusion I would like to reiterate what is immediately envisaged as the outcome of accepting ideas put forward in the paper.

As you can see, the first one would be a clearly defined and definite basic function for organizational forms. In the paper I refer to this as "providing accomodation." Secondly, an agreed list of necessary secondary functions for organizational forms, perhaps of design, etc., would be desirable, and third, a methodology for selecting alternative ways to realize all necessary functions is needed. Next an agreed list of performance requirements for all organizational forms is required; obviously the next step would be criteria for assessing the above performance requirements. Lastly, a model that would enable clients to select an organizational form capable of satisfying the basic and secondary functions while at the same time yielding the desired performance at the least monetary expenditure is needed. Professor Smothers in referring to the papers suggested that. I think he asked, is it really that simple? I do not think so. I think it is quite difficult and am in full agreement with him. He also mentioned the problem of user needs and thought this was an area of weakness in the paper. I looked at the construction industry as a total system and the aspect of organizational form as being a process within that system. If we look at that statement, we can also look at another process. If we want to talk about the process of the functions of client--briefly and equally--I would see the same theory being applied there to quite a good effect. In other words I would consider user needs as translated into necessary functions.

WILLIAM ORR (President, Cost Systems Engineers, Inc., Fort Worth, Texas): I call myself a construction cost-manager and all day today it has been borne out that we need a common language, because when I stop and analyze the word cost I really don't know what I do. Cost to a buyer is one thing. Cost to a seller is something else. So, what is cost? By the same token what is quality? I think communication is one of our biggest problems.

My paper, of course, was planned as a tool for improving the process, not as a means of evaluating the process. However, in line with the comments of the last speaker, it might be well if we took a look at process construction. Chemical engineering as such is a process and starts with a flow chart. Very shortly, I will offer as a part of the Orr System an evaluation of the process which will balance the incoming ingredients against the required output. Having balanced the chemicals, it will then proceed to design the key vessels and equipment. Having that designed, it will then allocate the cost. Quality is determined prior to cost. Cost includes quality, or it should, depending on how it is defined. Within the historical files of buildings which exist at the present time--commercial, residential and light-industrial--is the effort to expand the system to engineering type projects. The averages are done on a factual feedback.

About 5 years ago my company put out a glossary of terms for our computer programs. As this was written for my office, the

users of this program had to know what was meant. The system is designed to be flexible. It must be, as there are 300 users across the U. S.

The necessity of an actuary department for buildings is obvious. It was felt to be much simpler to build an actuary department for buildings than it would be for people, because buildings are much more predictable than people. The information contained within our actuary department of buildings is factual feedback on the projects that have been constructed as to cost, time and sequence. It's not really an estimate, it is a fact; other people have done it for this amount. It's then modified to any time and location in the world through modifiers.

Time and time again the word "productivity" is encountered. Productivity is an ill-defined word. It is used differently by different people. Even the word "system" is not a very good one. What is a system? The historical information provides us with coefficients of deviation given the extremes, the boundaries within which costs will fall. So the four points that were mentioned can be found within the Orr System. Quality, time, risk and cost have all been covered, although these four points are only a part of the Orr System. These are all parts of performance, and it is my hope that someday a tool will be provided that will improve the process, and conclude the final part of the Orr process program for the process industry so that not only is the cost of the plant in place provided but also a cash flow analysis.

AD-A045 708 CONSTRUCTION ENGINEERING RESEARCH LAB (ARMY) CHAMPAI--ETC F/G 13/3
PROCEEDINGS OF THE CIB W-65 SYMPOSIUM ON ORGANIZATION AND MANAG--ETC(U)
MAY 76

UNCLASSIFIED NL

2 OF 2
ADA
045708

END
DATE
FILMED
11-77
DDC

RICHARD VANDEN BOSCHE (AACE-SAVE-NSPE, Towson, Maryland): I'm not a cost or value engineer, I'm an artist, and my art form happens to be engineering. Once I got that clear to myself a lot of other things that are going on in the construction universe started to clear up for me. So, I wish to propose to you an hypothesis which is somewhat different from maybe all the papers we have read and the people we have heard. I've heard all kinds of problems having to do with terminology, with risk, with motivation, and with organizational survival. The first thing that becomes very obvious is there is no shortage of problems. I could name a few. How do we get rid of adversary relationships in the construction environment? Another problem is how do we get more individual involvement at all levels with every individual involved in this process? And then, how do we get to the basics, the real underlying basics of what's going on in this industry. The basics in this industry from my point of view are things like stones and bricks and people. Now it seems to me that I have heard a lot of discussion about something that's bigger than that, but it appears that we should not fool with anything bigger than the basics until we can really handle the basics. I don't think we can handle the basics yet, particularly those called people. I am going to propose some suggestions about some of the things we might take a look at doing with the basics, particularly the people. We have had all kinds of solutions presented: optimization of this and

that, use of subsystems, use of computers, need for more clarity in our definitions of things. We have heard all kinds of solutions: use of open shop, etc. Everything involves fixing something, or changing something, or doing something. I haven't heard anybody yet take a look at accepting our industry the way it is, identifying the way it is and proceeding from there to use it the way it is while trying to guide it into future growth. We have not heard how to build the team that works. We have not heard how to communicate effectively. The problem of communication has been identified, but nobody has suggested how we in this business could go about communicating effectively.

All the solutions that I've heard about so far appear to be based on a presumption that this is a rational business. I do not think so. I do not believe that this is a rational business. When one of the basics of the business is people, I submit that it's not a rational business because there are so very, very few totally rational people, and when you put a few irrational people into a situation which is in a constant state of flux, they do not accept the way it is; they keep trying to change it. It seems to me that we are creating a situation wherein a lie persists. In taking a look at the lie that persists we are complicating it. All of the solutions that we have heard do not tend to simplify. They tend to complicate. The only way to go, from my point of view, is to get down to the basics and the simplicity of what goes on in this business and then take it from there.

Is it necessary to measure effectiveness? Or is it that the things that are effective have a tendency to measure themselves? Maybe our job is to create effective ways of behaving for the basic building block, the people, and then let what is effective measure itself. How does it measure itself? It measures itself by the presence of money. Whoever has it at the end of the game obviously wins. Things which are effective measure themselves by the absence of litigation. Things that are effective measure themselves by the abundance of time that they create. Things that are effective measure themselves by satisfaction. Maybe we don't really need to measure anything in the way of organizational and management structures. Maybe we just need to let the structures that we have go ahead and do what they do and then take the problems as they occur and solve them step by step. There's no shortage of problems. There never will be.

Now, how can we do that? How can we go about taking it the way it is and letting it measure itself. Well, it already happens really because no matter what we do in this room, no matter what we do in this business, what works will survive and grow, what doesn't work will die on the vine. That becomes so abundantly obvious we still have the basic to deal with--getting the people more involved. Fount Smothers gave the example of the bond issue. We expect the guy down at the lowest level to produce for all he's worth, and yet we up here in management don't really tell the truth to him or ourselves. The goal is not to reduce the project

cost; the goal is don't blow the bond issue. How many other examples are there? Everybody in this room could think of another example about the pervasive lie that exists in this business. I don't know exactly how to get people in this business to start telling the truth so that we can start to measure our own effectiveness except to start doing it. If we operate in an environment that's a lie and we continue to try to fix it without telling the truth about what's really going on, all we get is more lies. That causes complications.

Many of these papers represent decisions on the part of people about how to go. That's making a decision. It's very difficult to operate at choice rather than at the effect of the decision concluded. When operating at choice you maintain your options. I'm going with a subsystem type situation; that's the way I'm going today, and every day I choose where I'm going rather than deciding back in the beginning that one way is the right and only way to go.

Let's face it, who really controls the organizational form in this business? The guy who gets to the owner first. The guy who gets an agreement with the owner first to be on the team is the guy who controls the organizational form. Now, what I am suggesting is that we deal with everything that happens after that decision. Not only that, but from all the points of view that we've had out here; they all work. They are all the one solution which we all came here looking for. My solution is <u>the</u> solution and Bill Orr's solution is <u>the</u> solution, everybody's solution is <u>the</u> one solution to all the ills of our industry. The final thing I want to say is

that I don't have a solution to the ills of this industry; there is no one solution and there are no thousand solutions to the ills of the industry. One of the things I suggested that we need to do is to take a look at it the way it is, accept the way it is and begin to improve it at the lowest level: the communication and the integrity that exist in the world. This requires something very difficult. We all have our own points of view. In order to get honest, what we really have to do is be willing to get off of our own point of view, to be willing to make room for somebody else's point of view in our life, so that we can all grow together and develop our industry together.

ROBERT FREW (Associate Professor, School of Architecture, Yale University, New Haven, Connecticut): What I would like to do is to define what I believe an organizational form to be and try to relate that back to my paper. First of all, the clients and the users that we deal with do have some inherent organization so that we have to either believe or not believe what the client is telling us. We also have organization of buildings which are the products of our industry. These buildings can be considered in many ways, as either organizations of rooms, activities, subsystems or whatever; we also have organization of production, which I think is a subject that is being addressed here. The terms cost, time and quality have come up. My paper addresses the problem of quality

and it talks about organization in terms of the users and in terms of the buildings that the users are going to get. I disagree with Mr. Meyers' paper, which I believe I am interpreting correctly, in the sense that he makes the comment that privacy is something that you can buy. I don't think privacy is something that has a cost. Privacy is what Livingston refers to as a second order utility that cannot be evaluated in terms of cost, and that is where the architect, as the designer, is or should be in addressing his buildings. In particular is the problem of the house, as it represents to me one of the most obscure areas of criteria formulation. It's very difficult to see why people might choose one house over another. That is one of the reasons why I got involved in operational forms. The operational methods that I have used, I've used because I don't believe you can ask someone why they want one house over another. In the CIB W-65 proceedings Volume I, Chapter III starting on page 110, you see four houses that represent many different results from one method. In house 1 and house 2 the concerns had to do with children and the privacy attitudes of the client towards children. In house 3 you will find that the attitudes had to do with the family's notion of their formal living pattern as opposed to their informal one and keeping those two styles very much apart. Now, those you might say are very, very simple decisions to make and you can in fact make them. My concern is that I get enough commissions to do a

sufficient number of houses to be able to make some fundamental statements about why people choose different houses.

Another of the results of this work is that the whole involvement of the client in the process of design is one of the critical elements. So it appears to me that when you talk about organization for production, what you really have to ask is how can you get the owner involved in the production of his own building.

In conclusion, I feel that these definitions of organization are important to me and are the reason why I am here. There appears to be a lot of confusion in terminology and usage which I would like to see clarified.

FOUNT SMOTHERS: One of the difficulties of this particular session is its diversity, which is one of the things that makes it so interesting. Professor Cakin, for example, talks about the situational criteria by which things need to be judged, an obvious situational criteria. In every project you have different criteria; you have one of the five things we have been talking about.

The profile of objectives for that kind of quality differs in every project that you are going into. It is never exactly the same. The situation is relative to cost. Some owners are highly concerned about initial cost because they are under the gun, so to speak, in terms of outside funding agencies, of outside funding limitations and perhaps operational funds which are to come from

an entirely different source. They do that in my department of architecture for example. I can hire people under one fund but I've got to supply them with secretaries under an entirely different fund. Because of this, I have vastly different feelings about how much one thing costs versus how much another thing costs. It doesn't all come out of one pot of money. Time, and people's situations in terms of time differ radically. So, yes, criteria by which one would select a particular organizational form vary with each individual instance, and each situation must be analyzed as an individual problem. That is what is interesting about it. It is the fact that you cannot assume that you have any one thing that is an overriding criterion. Minimizing the cost is an overriding criterion but a building that doesn't do its job, a building that people refuse to live in, even if it cost practically nothing, is a waste of resources. It is the kind of economy that you cannot afford. I really think Professor Cakin put his finger on it. The situational criteria and the ability to analyze them are really what it's all about; the ability to predict which specific configuration out of the real multitude can categorize the organizational forms that we have been talking about depends on these four or five categories: construction management, systems, bulk purchase, etc. You can lump them together into five categories, yet every time the details of the organizational form come out differently, and the decision becomes

which one is best for this particular client, in this particular place, at this particular time. Those are the kind of organizational criteria tools for analysis that we need to define.

TECHNICAL SESSION IV

MANAGEMENT METHODS IN CONSTRUCTION

RAPPORTEUR'S REPORT

Shlomo Peer, Professor
Head, Construction Management and Economics
Israel Institute of Technology
Technion City, Haifa, Israel

The two leading topics of this session are the development of new management tools for decision-making and the application of existing ones in planning, directing and controlling the construction process.

Dealing with research-development and its application, we cannot ignore, at the first international symposium on construction management and organization, the problem of the existing gap between research and reality. With the advent of the computer and new branches in applied mathematics, this gap is steadily widening.

This is a natural result in a situation where building research is originating and evolving outside the industry. It is quite understandable that managers in responsible positions hesitate to rely on models and techniques which they find difficult to grasp or follow. Researchers, on the other hand, being isolated from practice, see a greater challenge in the development of science than in its application.

Under the influence of Gilbreth, a founding father of management science, the building industry was one of the first in which an attempt was made to improve what has come to be known as productivity. Unfortunately, this early lead has not been sustained, and building ranks today among the most backward industries in the extent of its application of proven management techniques.

This slow acceptance of new techniques, which should be of special concern to the participants of this session, is emphasized

in the paper of Whitehead (IV-222), which reports an investigation conducted in Great Britain on the use of productivity improvement techniques in the building industry. The report summarizes answers to a questionnaire addressed to the industry on the extent of, and reasons for, acceptance or rejection of different techniques. The answers received seem to be typical of the situation in many countries. The author suggests that the main effort today should focus on expansion of education and training at all levels of management, on improvement of the managerial basis in the firms, and on compilation of basic production data, rather than on devising new sophisticated techniques which industry is far from being ready to implement.

Productivity measurement in Australian housebuilding is described by Woodhead (IV-236), who reports a study conducted to evaluate the technical aspects of construction, economics and other organizational features. Information on on-site productivity was obtained by video recording, which has proved a valuable tool for observing and recording interactions between on-site operations. Man-time measurement for specific activities and breakdown of the results into productive and non-productive time pointed out areas amenable to improvement.

The use of time-lapse photography as a macro-analysis tool for studying the whole process in the construction of an industrial plant is reported by Kroll (IV-149). The information obtained could be analyzed for productivity and safety control, for yielding

updated data on crew productivity, and identification of problems with specific activities. The effectiveness of using this technique in more complex buildings seems, however, to be very doubtful.

Adrian (IV-1), in his paper, outlines the development of a productivity model to serve as a means of measuring, predicting and improving the productivity of a given method. The model focuses on productivity parameters which lend themselves to measurement and control by the average construction firm. While this model does not invariably yield an optimal construction method, it has a potential of local optimization for a given method. Whether the proposed procedure has any advantages over established work study techniques is questionable.

The possibility of improving labor and equipment productivity through detailed pre-planning of field operations well in advance, instead of dealing with problems as they arise, is the theme of the paper by Birdsall and Woodhead (IV-43). The authors advocate an integrated approach to field management, dealing with the field operation as a profit center. Current cost reporting techniques in which the construction site is seen as a cost center and the dominant philosophy is meeting the cost estimate prevent head office management from recognizing the profits that can be gained by improved pre-planning and control methods.

The replacement of the traditional organizational charts by decision networks, and modeling the organizational functions as

nodes and the information input-output vectors as branches are proposed by Kaiser and Woodhead (IV-111). The development of such networks for the main decision processes, frequently performed in the normal operation of a company, should provide an effective tool for organization and control. These decision models could also assist in task allocation and in definition of information flow requirements for the development of integrated management information systems. The basic criteria for such an information system are outlined in the paper presented by Ragade and Handa (IV-209), who emphasize that it should be designed to achieve a healthy balance between unavoidable task-oriented conflicts between managers of different sub-project and project-units. Metagame-theory could be applied for conflict analysis, allowing the designer of a management information system to anticipate all potential areas of conflict between the different users.

A conflict situation between effectiveness and efficiency is unavoidable in a construction firm, as outlined by Kouskoulas (IV-128), who concludes that an effective information system must respond to the nature and needs of the firm without demanding organically difficult changes. The system should serve, as he states, the intuitive thinking process dominating construction operations, and should be flexible enough to interact and respond to various levels of intelligence. This compels use of a time-sharing computer system, structured in modular form, to allow any

of its components to be used independently. In the fact that integrated batch systems or too sophisticated models are favoring intellectual processes, the author finds a strong explanation for the failure of these systems to serve the construction firms.

Zakkak and Borcherding (IV-256) describe a cost control simulation program developed as a business-oriented management game for training purposes. It allows students to experiment with simulated construction problems and to analyze the financial aspects of a project with time-oriented budgetary cost control.

Björnsson's paper (IV-60) focuses on the development of a mixed-integer programming model for generating optimal material procurement strategies. This model is now being tested by a Swedish construction firm. The planning problem is to decide when procurement should take place, how large quantities should be ordered, and when deliveries should be made, so that purchasing, inventory and capital costs are minimized. Price forecasts originate outside the model, but it can be used to test the sensitivity of a strategy to the price trend assumed. The importance of this problem is emphasized by the fact that materials frequently account for more than half of the total construction cost. A small saving on this item can have, therefore, the same effect on the profitability of a company as a large increase in the total turnover.

The anticipated profitability and cash requirements over the

various periods of activity are two separate--although interlinked--problems. A business can survive in the short term without profit, but cannot do so without cash. The problem of forecasting cash flow is discussed by Peer (IV-164). The most problematic and laborious part of defining a company's cash-flow plan is forecasting of the cash-flow curve. As construction activities are performed in a certain technological sequence, the cumulative curve has an S-form, with slow acceleration at the beginning and gradual tailing-off towards the end. It seems likely that typical cost dependencies can be formulated for similar types of projects, as a function of total cost and construction time. This paper reports the results obtained in a feasibility study of a typical cost model for housing projects as a first step towards development of an integrated cash-flow planning system. Deviations proved to be insignificant for practice, especially when considering that management is concerned with the overall cash-flow of the company, rather than of the single project.

One of the most important applications of a management tool in construction in the past decade is undoubtedly the widespread use of network analysis. This involves a discipline of logic, which enables the process to be more clearly understood in terms of the sequence and interrelationship of the individual operations in the process. However, studies conducted in different countries have indicated that management's opinion of the effectiveness of

this technique is much lower than realized, and that it is generally being used by the contractor because it is required and paid for by the owner. All these methods originated as management tools for coordination and control of complex projects, and perform only simple arithmetic calculations with fixed activity durations estimated in advance, in the search for a critical path. This may comply with the needs of the client, who is concerned with event times for progress control and with coordination between independent organizations.

It should be recognized that none of these methods includes in its algorithm any calculations for solving the practical organization problems of the production process on the site. Consequently, as experience has shown, the resulting schedule is of limited use for contractor's site management, and the plans are quickly put aside before the work is really under way. The subsequent updating is then a permanent adjustment of the plan to the actual situation of the progress on-site.

Limitations on the use of network analysis as a tool for planning the production process are imposed by its basically unrealistic assumptions of unlimited resources that can freely be hired and fired, and of independent activities of fixed duration that can freely be shifted between earliest start and latest finish. The need for creating working continuity and balancing the whole process into an integrated production system is completely neglected.

The fact that no project can be carried out without regard to the question of resources has become quickly apparent, and a variety of resource allocation programs were developed trying to solve this problem. The difficulties in implementing such programs are discussed by Popescu (IV-196), who presents a summary of 27 available computer programs for resource aggregation, leveling and allocation. The author considers the implementation as a problem of choosing the right program and of the expertise of the person assigned to this job.

Peer and Selinger (IV-156), however, are skeptical about the practical value of all these programs, which, in spite of their sophistication, may be interesting from the theoretical point of view, but are incapable of transforming the original unrealistic schedule into a practical solution for the site. The first basic difficulty with this approach lies in specifying the upper limit for the resources. The computer cannot use statements like "as many as are needed so long as they have continuity of efficient employment for a reasonable time period." This input can, therefore, be provided only by accidental guessing. Another shortcoming of these programs is acceptance of uneven use of the resources, so long as they do not exceed the given upper limit. The main discrepancy between approach and reality lies, however, in the assumption that activity durations are fixed. This is especially untenable in construction, where the bulk of the activities is

performed by labor crews, with duration being a function of crew size.

A basically different approach to the planning of the construction process is taken by Peer and Selinger (IV-156), who report on a new technique involving an input of fundamental production data such as work quantities, production rates, and other production characteristics. Time data, activity durations and optimal crew size are obtained as the output of the program, which analyzes the construction process as an integrated production system. The computation method is mainly based on dynamic programming, taking advantage of the affiliation of activities to production lines. The program consists of a set of algorithms which are suitably combined for a given project in accordance with its specific requirements.

A computer-based simulation of repetitive housing construction using Monte Carlo methods of sampling is reported by Pilcher and Oxley (IV-172). An attempt is made to determine the effect of certain variables on the selection of a buffer time between the start of activities to optimize project costs. Conclusions are drawn, based on some assumptions, as to the size of a project related to the completion rates, and how the variation in site-overheads is related to the buffer times.

The building process is usually underway long before the

contractor comes into the picture, and Brown (IV-74 and IV-85) summarizes in his papers the experience gained by the Department of National Defence in Canada in implementation of different organizational forms in the design and construction process, and their impact on time and costs; he does not, however, provide any quantitative data.

A paper on computer-aided design was submitted by Armas (IV-17), who describes the first actual design of a hospital by this means. It can be expected that the ability of the computer to store organized information will enable the architect to devote more time and expertise where they are most needed. Improved interaction between design and production is probably the greatest single step that can be taken to facilitate improved productivity. This is hampered, however, by shortage of basic feedback data from the production process.

The lack of fundamental management information input is also relevant to the general problem of making new management techniques practicable. The rapid expansion of construction management research in the past decade took the form of random and uncoordinated initiatives with very little impact on everyday practice. This, in turn, created a steadily widening gap between research and reality. This is a problem which should be discussed at this symposium, which provides an excellent opportunity for those engaged in research and practice to gain a better insight into the

reasons for this gap and to discuss goals of future development. This is essential in an industry where research is remote from the environment of production. We cannot ignore the fact that use of management tools in the solution of real-life problems is still very limited today. To quote a contractor in Whitehead's questionnaire, "I cannot see much use for the most sophisticated operational research techniques since we, as an industry, have not yet learned to walk and must do so before we think of running."

It seems that what is urgently needed in the near future, in order to speed up improvement of building productivity for the benefit of the society which we aim to serve, is for the scientist to pay more attention to the practical aspects of research. Without detracting from the need to extend the frontiers of knowledge, research should see more challenge in developing better ways of making its findings operational.

NOTE: Technical difficulties prevented the recording of the discussion following Professor Peer's presentation and of the symposium summary presented by Dr. Louis R. Shaffer, Coordinator of CIB W-65.

ADDENDUM

COMMENTS ON SESSION II

ORGANIZATIONAL FORMS FOR CONSTRUCTION

Major John L. Richards
Assistant Professor
Department of Engineering
U.S. Military Academy
West Point, New York

I will not attempt to repeat the very excellent summary of the papers made by Professor Pilcher in his rapporteur's report. He enumerated a list of factors called from all of the papers. However, I did see four trends throughout the discussion:

A. Semantics - Much of the discussion of communication problems really boils down to a question of Semantics.

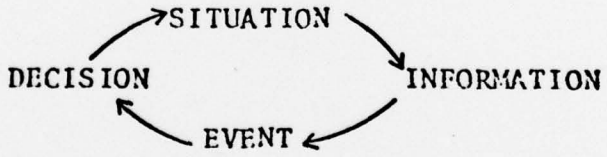
B. Relationships - Relationships between parties in the construction process are undoubtedly much more complex than most people realize.

C. Measurements - Criteria for any sort of evaluation of the factors are difficult to come by.

D. Risk - This rather broad concept embodies the above three trends and seemed to be common throughout the discussion.

The rapporteur's summary was followed by individual presentations:

A. Mr. Mouterde discussed his paper, "Communications Networks," in which he viewed the decision-making process as a cycle:



This process must be integrated into three plans:

1. The human plan
2. The technical plan
3. The economical plan.

B. Dr. Diepeveen pointed out the semantic jungle of the topic and also the problem of measuring performance of a particular organizational form.

C. Mr. White discussed integrated building systems as an approach to the problem.

D. Dr. Richards proposed the concept of risk as an approach to measuring effectiveness.

E. Mr. Cleland discussed the use of pre-planning groups, either in a separate or integrated mode.

F. Mr. Silverman discussed pre-design planning (a management plan) as an approach to organizational forms.

G. Mr. Hack discussed the problem from a work breakdown structure viewpoint. He felt that labor productivity is not the real problem.

H. Mr. Hill discussed daily management of labor and unit costs. He also said any incentives must be built in very carefully.

I. Professor Pilcher made his summary by stressing that a measure of effectiveness is not whether the job is over or under budget. He also pointed out the aspect of market influence. He agreed with the pre-planning group notion and mentioned bulk ordering.

J. Dr. Diepeveen made some final comments that a building team should be recognized as an organizational form and that lump sum bids at least have the advantage of saving the difference between the highest and lowest bid.

In summary, I think continued research needs to be directed toward defining the organization and management of construction. The papers and discussion presented at the symposium serve to point out the need for a normative model of OMC and the need to accurately define this process.